INFORMATION AND COMMUNICATION TECHNOLOGY ADOPTION AND INCLUSIVE GROWTH IN WEST AFRICA

BY

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BEING

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DECLARATION

I, EJEMEYOVWI, Ogaga Jeremiah hereby declare that this dissertation is my original work and that no portion of this work has been or will be submitted in support of an application for another degree or qualification of this or any other university or other institution of learning.

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CERTIFICATION

This is to certify that this research work, written by EJEMEYOVWI, Ogaga Jeremiah was supervised and approved in partial fulfilment of the requirements for the award of Master of Science (M.Sc.) Degree in Economics from the Department of Economics and Development Studies, College of Business and Social Sciences, Covenant University, Ota, Ogun State, Nigeria.

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DEDICATION

I dedicate this research work to God Almighty, to my Dad, Mum, current and future family.

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LIST OF ABBREVIATIONS

GDP – Gross Domestic Product

GPT – General Purpose Technology

GMM – Generalised Method of Moments

HDI – Human Development Index

ICT – Information and Communication Technology

INVIT- Investment in Telecommunications

ITU - International Telecommunications Union

ICTEE – ICT Empowered Economies

ICTAE – ICT Adopting Economies

ICTDE – ICT Deficient Economies

ICT-NRI - Networked Readiness Index

MCS – Mobile Cell Subscribers

TAM – Technology Acceptance Model

UN – United Nations

UNDP – United Nations Development Programme

UNESCO – United Nations Economic and Social Council

WDI – World Development Indicators

WGI – World Governance Indicators

WEF – World Economic Forum

ABSTRACT

West African countries experience economic growth in terms of financial figures but the issue of non -inclusiveness of this growth in terms of human development is becoming worrisome. This study empirically examines the role of information and communication technology adoption on human development and the direction of causality between them using data for 15 West African countries (2004 – 2014) estimated with the system Generalised Method of Moments (GMM) and Granger causality test. The GMM results showed that internet usage and investment in telecommunications have a statistically significant relationship, while mobile cell subscription has a statistically insignificant relationship with human development. The Granger causality test result showed that ICT adoption does not granger cause inclusive growth at the immediate and next annual time period. The study concludes by recommending the increase in investment in the telecommunications industry, the rendering of tax holidays to domestic firms in the IT industry, the creation of awareness of the productive use of ICT in all sectors of the economy for human development and inclusive growth to be achieved overtime.

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Fundamental questions such as "what has been happening to poverty, unemployment and inequality?" were asked by Dudley Seers at a conference presentation in New Delhi (1969), which have generated contemporary relevance. Seers noted that if one or two of the three (poverty, inequality and unemployment) is increasing; it will be strange to say that the country concerned is achieving development - inclusive growth. These questions take into cognisance the social factors such as the standard of living of the populace in the definition of development. It buttresses further, the importance of inclusive growth.

Statistics show that economic growth has a significant role to play for the decline of poverty, inequality and unemployment in all economies. The level of poverty and inequality in relation to the economic growth rate in West African countries leave researchers in a quandary- dilemma (Abejo, 2013). In 2003, the growth rate of Gross Domestic Products (GDP) of Nigeria was 10.4 percent, which grew to 33.7 percent by 2004 (World Bank, 2016). As at 2013, there was an increase in the growth rate by 6.3 percent which showed increase but at a decreasing rate. Cape Verde (2007 - 2011) experienced an average GDP growth rate of 5.8 percent while Ghana experienced an average growth rate of 8.3 percent within that same period (Trading Economics, 2016). This growth was accompanied by improved market dynamics, increase in economic activities and despite that, the level of poverty, inequality and unemployment still don't seem to be decreasing at a fast pace.

Poverty and Inequality levels are relatively high in West Africa. The Poverty headcount ratio statistics at $1.9 per day (2011 PPP - percent of population) shows that the percentage of poor people compared to the total population in West Africa reduced from 58 percent to 45 percent as at 1990 and 2010 respectively after much fluctuations and later increased to 45 percent at 2015 (World Bank, 2016).Despite this reduction, the rate is still very high compared to the total population. The Gini coefficient index of some countries in West Africa like Nigeria shows that West Africa is approaching the line of inequality despite the recent fall from 51.9 percent in 1996 to 42.9 percent in 2016. Unemployment rate in West Africa was varied for the different

countries; having a range of at most - 30 percent and at least - 6 percent overtime (Trading Economics, 2016).

Statistics specifically, in terms of human development show that the average life expectancy for West African countries such as Cape Verde (male - 75 years; female - 71.4 years), Sierra Leone (male – 51.4; female –50.4), Niger (male – 62.4; female – 60.6), Nigeria (male – 53.1; female – 52.4), Mali (male – 57.8; female – 58.2) and the expected year of schooling (education) for West African countries such as Cape Verde (male - 13.1; females - 13.9),Sierra Leone (female – 7.2; male - 10), Nigeria (female – 9.8; male -8.2), Mali (female – 9.3; male – 7.5). Countries with high inclusive growth and human development are characterised by average life expectancy of 86 (females) and 80 (for males) and a range of expected schooling year of 17 – 20 years (for females) and 16 to 19 years (for males) (UNDP, 2015). It is evident for West Africa that during the period of exponential economic growth, the levels of inclusiveness in terms of education attainment levels, health care availability, and so on did not increase significantly and responsively. It can be seen here that for countries to experience inclusive growth, economic or financial improvement alone is not sufficient.

There is an accord in the existing literature that being a knowledge-based economy is crucial to achieving inclusive growth (Tchamyou, 2015; Kuada, 2015; Asongu & Le Roux, 2016). The World Bank's Knowledge Economy Index (KEI) comprises of three components – "education, Information and Communication Technology (ICT) and innovation". Among the components, ICT is probable to exert the highest impact on economic and human development landscapes because of its potential for wide and fast adoption and penetration (Asongu & Le Roux, 2016). Knowledge-based economies have a higher chance of confronting the challenges that globalisation poses to development. The Asian tigers have shown that countries of the world can leap-frog the stages of development and achieve sustainable development by applying the Knowledge - Economy principle (Johnson, 2016).

ICTs are referred to as "General Purpose Technologies" (GPTs) by economists (Atkinson, 2009). GPTs are technologies that cut across all sectors of the economy and are known to have practical usefulness in those sectors. ICTs have been found to increase productivity and output, reduce cost of transportation and many other benefits. According to World Bank Report (2009), there was a 1.3 percent growth increase with every 10 per cent rise in the speed of internet connection.

Honk Kong (2015) had a population of 7.188 million people; yet, the number of internet users make up 68 percent of the total population (4.873 million).Israel (2015) had a population of 7.7 million, yet, the number of internet users make up 59 percent of the total population. This shows a high level of technology usage which contributes to the overall efficiency, production and growth (inclusive) of the respective economies. This inclusive development is evident in their respective contributions not only to their countries but also to the world as a whole. The number of internet users, mobile phone users and fixed telephone lines in West Africa has been experiencing an increase in the past decade.

ICT during this era of globalisation plays a crucial role in the growth and development of an economy; it is among the indicators used in measuring the degree of sophistication of the investment 'climate' of a country. ICT can be viewed as a tool to increase efficiency and save time. ICT is a dimension (subset) of technology (alongside electricity production, transportation, and so on) that can be viewed as an obligatory indicator of the level of development attained by an economy and given the current trend of globalisation, ICT is a major tool for achieving this goal.

Old and conventional mediums of communication (birds and smokes for signal) have been faced-out due to many limitations some of which are inefficiency, ineffectiveness, non-promptness, to which could be attributed to the advent of globalisation (Atkinson, 2009). The argument for developing countries to globalize is important and is designed to enhance access to foreign capital, improved technology in order to enhance the prospect for larger markets (Alege & Osabuohien, 2013). Globalisation has led to several innovations in technology such as the internet (Advanced Research Projects Agency-ARPA, 1962), mobile phones (1990s), television sets, personal computers, radios and others that have made communication everywhere around the world easier and faster. These modern tools for communication are collectively called ICTs (Olise, 2010).

However, it is important to note that the determinants of a country's economic growth include human capital, physical capital as well as technology (Solow, 1956). ICT can be used to drive inclusive growth in major sectors of the economy. Countries such as India and USA have used ICT as tools to promote inclusive growth and sustainable development. West African countries

can also adapt such methods. This study seeks to investigate the determinants of inclusive growth as well as the influence of ICT adoption on inclusive growth.

1.2 Statement of the Research Problem

Most researches on ICT adoption have focused on achieving economic growth through ICT (Jack & Suri, 2011; Muralidharan, Niehans & Sukthankar, 2014; Imbert & Papp, 2015; Ghosh, 2016) without much emphasis on Inclusive growth and human development. Some researchers investigated ICT adoption in specific subsectors and sectors like the banking sector (Osabuohien, 2008), the role of institutions in technological utilisation in Africa (Efobi & Osabuohien, 2015, the challenges and opportunities in technological diffusion and economic progress in Africa (Osabuohien & Efobi, 2012) ICT and Productivity (Ark et al, 2002; Daveri, 2002; Jorgenson 2003).

In terms of nature of research method, some researchers used primary data to evaluate the impact of ICT on Economies and Businesses due to the insufficient nature of large ICT data in the West African part of the world (which is due to the lateness in the adoption of ICT in this area) and the relative scarcity of research in ICT penetration in the area, while some others used cross-sectional data for correlations (Asongu, 2013; 2014), extended the research to causality (Asongu *et al*, 2016) for sound policy implications. Few works made use of secondary data.

Previous researches have used other instruments such as micro financing, financial inclusion as possible solution suggestions to solve the problem of non-inclusive growth in economies, focused their study on the role of ICT in economies in Africa, single countries, and other continents. The uniqueness and novelty of this research is seen in the use of secondary advanced panel data for the quantitative analysis of ICT adoption in West Africa. This study adds to the literature on the examination of the role of ICT in influencing inclusive growth in West Africa.

The questions being deliberated on are: Why have most West African countries not taken advantage of available ICT? Can ICT spur inclusive growth in these West African countries? What sort of policies should be enacted to improve ICT adoption and penetration that can spur inclusive growth in West Africa? This study seeks to provide answers to these questions raised.

1.3 Research Questions

The research questions that guided the course of this study include the following:

i. How does ICT adoption influence inclusive growth in West African countries?
ii. What is the direction of relationship between ICT adoption and inclusive growth in West African countries?
iii. What are the determinants of inclusive growth in West Africa?

1.4 Research Objectives

The general objective of this study is to examine the role of Information and Communication Technology (ICT) in engendering inclusive growth in West Africa. Thus, the specific objectives were to:

i. Examine if ICT adoption is a determinant of inclusive growth in West Africa; and
ii. Assess the direction of causality between ICT adoption and inclusive growth in West Africa.

1.5 Research Hypotheses

The hypotheses that were tested in this study include:

i. H_0: ICT adoption does not contribute significantly to inclusive growth in West Africa
   H_1: ICT adoption contributes significantly to inclusive growth in West Africa.

ii. H_0: ICT adoption does not granger cause inclusive growth in West Africa at the immediate or next time period
   H_1: ICT adoption does not granger cause inclusive growth in West Africa at the immediate or next time period

1.6 Scope of the Study

This study aims to examine ICT usage in fifteen West African countries namely: Benin, Burkina Faso, Cape-Verde, Cote d'Ivoire, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sierra Leone, Senegal and Togo. The Gambia was omitted because of excessive fragmentation in the dataset that could influence the result of the estimation negatively. The variables used to capture ICT are the number of mobile cell subscription, number of internet users and the investment in telecommunications while human development is captured by human development index (HDI). The dataset spans from 2004 to 2014 for fifteen countries in West Africa in order to reduce panel attrition (gaps in the dataset that could affect the result negatively).

1.7 Sources of Data

The data for the study was sourced from secondary sources, which comprise World Development Indicators-WDI, World Governance Indicators – WGI of the World Bank and United Nations Development Programme (UNDP, 2015).

1.8 Method of Analysis

The methodology used to ascertain the degree of pass - through of ICT adoption to human development in West Africa given the nature of the data (dynamic Panel data) is the Generalised Method of Moments - GMM and to ascertain the direction of causation between ICT adoption and inclusive growth, the Pairwise Granger causality is used. The estimation of the dynamic model is done with the system GMM estimator because of the advantage of this methodology- its ability to control for dynamic endogeneity that arises when some of the variables are determined within the system. It combines a differenced equation with a level equation. The study adopts the system GMM estimation procedure since first difference GMM may suffer from weak instruments problems (Blundell & Bond, 1998) and magnifies gaps in data set hereby producing more spurious results.

1.9 Significance of the Study

Notwithstanding the current policies and efforts that have been recommended by researchers and made by government officials to ensure inclusive growth, more can be done to achieve the desired result. The significance of this study is seen in a number of ways to policy makers, researchers, analysts, business operators, among others. This project attempts to proffer a way to increase efficiency within a limited amount of time across wide locations. The adoption of ICT by sectors such as the health sector, education sector, agriculture sector and others will have a significant impact, thereby, causing inclusive growth in all sectors, creating opportunities for all.

The project findings are expected to provide useful information to policy makers in ICT implementation and its effect on inclusive growth, how it could assist in the development of every economy (at the micro as well as the aggregate level), which will serve as a propeller towards inclusive growth and sustainable development. The research outcome sheds light on astonishing ideas that would assist developing and developed countries on ways in which they can leverage on the increasing level of ICT adoption towards achieving inclusive growth and sustainable development. The study will also serve as a basis for further research by scholars into the area of ICT in relation to economies and economics.

1.10 Outline of the Study

This study is comprised of six (6) chapters. The first chapter consists of a brief overview of the study; the second chapter is the review of relevant literature on what has been done in related studies. The third chapter is made up of the stylised facts which show the trend of the variables used in this study within the period of interest. Chapter four contains the theoretical framework, model specification and estimation technique. Chapter five consists of the result of the analysis and discussion. The sixth chapter is made up of the recommendations and conclusion.

CHAPTER TWO

LITERATURE REVIEW

This chapter of the study contains the conceptual framework, which looks at the conceptualisation and definitions of variables of interest used in this study in context of this research, the theoretical review – the review of theories relevant to the variables and model, the empirical and methodological review, followed by the ICT framework and models, how ICT adoption links to inclusive growth, and the limitations of ICT adoption in West Africa. The chapter ends with a summary of main issues deduced from literature and the gaps found.

2.1 Review of Conceptual Issues

"Growth must benefit and involve everyone. On the part of governments, Inclusive growth can be supported by having public services from health care to education to public safety, reach everyone, in particular in remote and less developed areas. At the global level, there is the need to make enhanced ICT connectivity part of the Post-2015 Development Agenda." (Shinawatra, 2013)

The former Prime Minister of Thailand, in her main theme address at the Connect Asia-Pacific Summit 2013, stated that ICT connectivity is necessary for inclusive growth and development. Shinawatra (2013) stated further that "ICT enhanced trade and investment by connecting businesses to customers and sources of finance from around the world; having small and medium enterprises in mind through digital social media advertising (on the web), making them more competitive. Shinawatra emphasised that ICT closes gender gaps, empowers people with better access to information and finance, grants better health coverage through remote monitoring and diagnosis, help ensure 'open education resources' such as long distance learning".

2.1.1 Information and Communication Technology

Information and communication technology (ICT) has been defined in varying ways. ICT is an umbrella term for any Information and Communication device, applications or its content (International Telecommunications Union, 2013). This definition covers a wide range of

technologies which includes radio, television, satellites, mobile phones, fixed lines computer networks, hardware and software. ICT provides a healthier and more equitable society by improving access to facilities that stimulate economic prosperity for a larger percentage of the populace.

The European Commission (EU, 2001) defined ICT to denote a term concerned with the storage, processing, dissemination and management of information and knowledge adopting various types of software and equipment in a digital and non-digital form. ICT can be broken down into three components – services, application and technology. Services entail the internet, emails and so on. Application involves management information systems, distance learning and teleconferences while technology ranges from the traditional technology (radio, television, accounting ledgers) to modern technology (cellular phones, internet access facilities).

2.1.2 Inclusive Growth

The issue of Inclusive growth originated in the mid-1930s after the great depression and the Second World War. It was observed by researchers that countries could be growing in terms of their gross domestic product and still be having high inequality rate, unemployment rate, low standard of living, and so on. This led to the agitation for inclusive growth in all countries in the world (Johnson, 2016).

The World Bank refers to inclusive growth to denote both the "pace and pattern of economic growth, which are assessed and interlinked together". The rapid pace of economic growth is necessary for reducing absolute poverty, but for sustainability, it should be broad-based across sectors and inclusive of the large part of a country's labour force.

Inclusive growth refers to direct links between the macroeconomic and microeconomic determinants of economic growth. The microeconomic aspect refers to economic diversification and competition, while the macroeconomic dimension refers to the changes in macroeconomic economic aggregates such as gross domestic product, total factor productivity, employment, and so on. Inclusive growth advances equitable opportunities for economic participants during economic growth with benefits incurred by every section of the society

Paloma (2015) viewed inclusive growth in terms of necessary and sufficient conditions; the classical poverty reduction condition and the sustainability condition. The classical view focused on the importance of reducing the poverty rate to ensure inclusive growth. The sufficient condition for inclusive growth is seen when the poverty reduction strategies of the country are increasingly sustainable. "Inclusive growth is economic growth that creates opportunities for all segments of the population and distributes the dividends of increased prosperity, both in monetary and non – monetary terms, fairly across society" according to the Organisation for Economic Co-operation and Development (2014).

Inclusive growth does not only create new economic opportunities for people but also ensures that these created opportunities are equally accessed by all segments of the society, particularly the poor (Ali & Son, 2007). Inclusive growth is concerned with the inclusiveness of the citizens and the development of the citizens of a country – human development.

Human development further entails the ability of people to live the kind of life that they choose and with the provision of instruments and opportunities so they can make their choices (UNDP 2004, 2008). Human development could be viewed as the development of the human capacity and the process of enlarging people's choices (Bankole, Shirazi & Brown, 2011). It comprises of three essential choices – longevity and healthy nature of life, knowledge acquisition through education and a quality standard of living (UNDP, 2015). The health, educational and quality standard of living components of human development captures adequately the OECD (2012) multidimensional framework for inclusive growth in terms of income and non – income growth (World Economic Forum- WEF 2015).

2.2 Review of Theoretical Issues

Models and theories have been developed overtime which show various technology adoption models and how they support inclusive growth. Below are the theories that are relevant to this research.

2.2.1 Technology Acceptance Model

The technology acceptance model (TAM) posits that the acceptance and eventual use of an information technology by a user are premised on and determined by two factors: the perceived utilities or usefulness to be derived and the perceived ease of application. Perceived utility denotes the extent to which the user believes the adoption of the technology will assist to enhance the individual's job performance and productivity while the 'perceived ease of use', represents how easy the usage of the technology is. TAM is a theory of information systems that models how users come to accept and use a technology. The model was proposed initially by Davis (1989).

TAM was seen to not include some crucial factors and was therefore, augmented to include social influence and the normative beliefs of others. TAM was the transformed into technology acceptance model – theory of planned behaviour (TAM-TPB) TAM-TPB was proposed by Taylor and Todd (1995). Agarwal and Prasad (1998a, 1998b) complemented TAM by adding the construct of compatibility- TAM2.

2.2.2 The Unified Theory of Acceptance and Use of Technology

The unified theory of acceptance and use of technology argued that the adoption of any technology by individuals is based on four key constructs; performance expectancy, effort expectancy, social influence and facilitating conditions. Performance expectancy emphasises on the extent to which an individual believes the adoption of that technology will help to achieve goals – the expected performance. The effort expectancy measures the ease in the use or adoption of a particular technology. The Social Influence measures the perception of others towards the adoption of the technology – the environmental factor. The facilitating condition measures the user's perception of the degree of need for the technology – an existing framework (Venkatesh, Morris, Davis & Davis 2003).The first three factors focus on the usage intentions and behaviour while the last one focuses on the user behaviour.

2.2.3 Technology- Organisation – Environment Model

The technology – organisation – environment theory posits that the adoption of technology by a firm, for example, is influenced by three factors; the technological factor, the organisation factor, the environment factor. The technological factor consists of the internal and external technologies that are relevant to the firm. The organisational factor describes the size, managerial structure, human resources, linkages among employees, financial resources, and so on. The environmental factor consists of the structure of the industry, the regulatory environment, macroeconomic environment, and the competitors. This can be applied to countries and individuals. The technology must be relevant and necessary to be adopted. The TOE model was propounded by Tornatzky and Fleisher (1990).

2.2.4 Diffusion of Innovation Theory

Diffusion of Innovation theory proposes that four elements influence the spread of a new idea: the innovation itself, communication channels, time and a social system. The diffusion of innovation theory explains why, how and at what rate technologies and new ideas spread. This theory was propounded by Professor Everett Rogers (1962). Rogers proposes that diffusion of innovation requires communication channel overtime among the participants in a social system. Rogers (2003) argues that diffusion is the process by which an innovation is communicated overtime among the participants of a social system. It explains patterns of adoption and predicts how unsuccessful or successful a technological innovation will be (Tan & Eze, 2008).

Diffusion of innovation theory is used majorly for research and analysis purposes to know where technology adoption is most appropriate like in the case of education (Sahin, 2006). Triplett (1999) in his study tested and proved that technical innovations assist in an economy. The author discovered that there must be improvements in diffusion through information technology (IT) investment.

2.2.5 Search and Matching Theory

Search and matching theory is a framework attempting to describe the formation of mutually beneficial relationships overtime. Matching theory evolved from search theory. Search theory is

an economic theory pioneered by Professor George Stigler in his article "The Economics of Information" in 1961which led to economics of search. The theory has been improved upon by a number of economists like Rothschild, Nelson, Stiglitz, Varian and so on. This theory has been applied to several areas of economics – labour economics, asset pricing in capital and money market, and so on. Matching theory studies the macroeconomic outcome when one or more individual 'searchers' interact.

Search theory analyses the friction with respect to information symmetry among users in the various sector and industry value chains. The study of the buyers and sellers who cannot find trading partners must search before transacting a business. In agriculture, studies must be carried out to match the producers to the distributors to the buyers. In labour economics, the frictions – information asymmetry between the employer and potential employee are studied. The problem of information asymmetry can be reduced to the barest minimum via the wide adoption of Information and communication Technology.

2.2.6. The Endogenous Growth Theory and Schumpeterian Model of Growth

Endogenous growth theory proposes that sustainable growth is determined by forces within the system. The forces within the system are the growth rate of the total factor productivity (TFP) which is determined by the rate of technical progress. The sustainable economic growth is measured by the growth rate of output per person. The endogenous growth theory suggested that innovation mechanism in form of new products and processes and markets are major economic factors that influence sustainable economic growth.

The endogenous growth theory was initially AK theory by Frankel (1962) which merged the capital and technical progress. AK Theory was improved by Romer (1990), who introduced intellectual capital (human capital) as a separate factor from physical capital. The next improvement was developed by Aghion and Howitt (1992), Grossman and Helpman (1991) where imperfect markets, research and development were added to the model. This was the Schumpeterian theory.

The Schumpeterian model of growth is an extension of the endogenous growth theory. It has three basic determinants of growth within an economy – Technology (A_i) such as ICT, socio-

economic setting (S_i), including institutions and the conventional growth components (X_i) (Schumpeter, 1991; 2005; Becker *et al.,* 2005; Bazhal, 2016).

"There exists a consensus on a two- way causality flow between knowledge and economic development - as opposed to the neo-classical models and theories of economic development which consider knowledge and technology as exogenous public commodities to the economic system" as posited by Asongu and Le Roux (2016). New economic progress is founded on both endogenous interpretations and neo-Schumpeterian perspectives of economic development.

Recent literature has shown that compared to other world regions where ICT adoption has reached saturation levels, there is still much room for accommodation of ICT in Africa (Penard *et al*., 2012; Asongu, 2015a; Asongu, 2016). West Africa has the potential for ICT adoption which could help in curbing extreme poverty which is seen in evidence in other regions of the world.

2.3 Review of Empirical and Methodological Issues

These studies were reviewed to gain insight into pertinent empirical and methodological constructs down to the current state of knowledge in this area.

Recently, Asongu and Le Roux (2016) worked on "Enhancing Information and Communication Technology for Inclusive Human Development in Sub-Sahara Africa". The study examined if increasing ICT improves all-encompassing human advance using a sample size of 49 countries in Sub-Sahara Africa for the period 2000 to 2012. The methodology used was the instrument variable Tobit regressions, in order to account for simultaneity and unobserved heterogeneity. The data used to capture human development characteristics; the income levels, legal origins, religious dominations, political stability and resource wealth. Six variables were used to account for omitted variable bias. Namely; development assistance, private domestic credit, remittances, foreign direct investment, GDP per capita growth and primary school enrolment. The result of the studies showed that policies designed to boost ICT (mobile phone, internet, telephone) penetration will increase inclusive development in the post-2015 sustainable development programme

Within the same period, Asongu and Nwachukwu (2016) investigated the role of governance in mobile phone penetration for inclusive human development in 49 countries in Sub-Saharan Africa (SSA) with data for the period 2000 – 2012. Six governance indicators were used, namely; voice, accountability and political stability, no violence for political governance, government effectiveness and regulation quality for economic governance and corruption control and the rule for institutional governance. The study uses a battery of interactive estimation techniques, namely: fixed effects, generalised method of moments and tobit regressions. The results from the battery of interactive estimation techniques show consistent evidence that the interactions between the mobile phones and governance variables have a positive correlation between mobile phone penetration and inclusive development in sub- Saharan Africa. Given the objectives stated, the methods were cumbersome but helped to make the work robust.

In a related note but with different scope, Ghosh (2016) researched on the impact of mobile telephony on economic growth using a dataset on 14 major Indian States (2001 – 2012). The paper had two objectives- to determine the impact of mobile telephones on economic growth and to further examine whether financial inclusion is one of the channels through which mobile phone penetration affects economic growth. An advanced panel data technique- generalised method of moments (GMM) is used for the analysis to determine the impact of mobile telephony on economic growth while the fixed effect regression was used to determine whether mobile telephony is a key factor in driving financial inclusion. The evidence suggests that mobile telephony exerts a significant and non- negligible positive impact on economic growth. The findings also testify to the fact that mobile telephones exert a positive impact on financial inclusion, especially for the use of loan and deposit accounts. One weakness of the work is the fact that 14 States out of the 29 States in India were used in the analysis. Nevertheless, the beauty of the research work is seen in its methodology and the simplistic justification and simplification.

On the other hand, Johnson (2016) researched on the role of information and communication technology adoption in delivering Inclusive growth, introducing the approach of the ICT-Inclusive Pyramid. The study modelled Nigeria, Kenya, India, Zimbabwe, South Korea, Japan and the USA utilising the Pearson's Product Moment Correlation Coefficient to categorise countries into ICT Empowered Economies (ICTEE), ICT Adopting Economies (ICTAE) and ICT Deficient Economies (ICTDE). Johnson discovered that countries that are ICT empowered

are characterised by high level of inclusiveness, vibrant ICT infrastructure, low inequality, low unemployment rate, high enrolment rate, large human capital development, and largest ICT investment. ICT adopting economies are characterised by moderate level of inclusiveness, relatively less robust ICT infrastructure, relatively high poverty and inequality rate, relatively high unemployment rate. ICT deficient countries are characterised by poor level of inclusiveness, huge digital divide, low human capital investment, poor investment in ICT infrastructure, poor ICT infrastructure, very high unemployment and inequality rate.

At an earlier period, Stanley *et al* (2015) investigated whether ICT generates economic growth. The methodology used was a meta-regression analysis of 58 studies that investigated the impact of ICT in economic growth. The researchers coded the study titles, year of publication, method of data collection, noted down the four popular ICT variables; landlines, cell phone, IT and internet as well as the GDP growth and other related variables. For the telecommunications-growth effects, partial correlation and Fisher's z-transformed correlation effect size. Evidence showed that majority of the publication selections were in favour of positive economic growth effects on the average. The main idea of the work was to determine clearly the role of ICT in economic growth. Care was taken to observe the works that accounted for endogeneity problems associated with the variables.

In terms of ICT and sector analysis, Akinmuda (2014) examined the role of Information and communication technology on Agricultural output in West Africa. The objective of the study was to determine the role of ICT adoption in increasing the agriculture sector output. The study spanned the scope of West Africa within 2000 - 2011. The method of analysis used was the fixed and random effects panel data analysis. The Cobb Douglas production function was used for the design of the model. The variables used were agriculture output, capital, labour, number of cell phone users, personal computer users and number of internet users. The study found that only the number of internet users had a very significant positive statistical role in determining the total agriculture output. The study recommended that training centres should be made for farmers to increase the literacy level (in terms of ICT and basic communication language) to in turn, increase the level of ICT usage and to ensure reduced price of these ICT tools for farmers. The number of personal computer owners and the number of mobile cell phone users didn't seem to have a significant positive impact on the agricultural output. The research was thorough but

some of the limitations of the work influenced the results – limitations such as the use of general ICT variables of the whole economy to represent the ICT variables used in agriculture.

In terms of comparison, Niebel and Mannheim (2014) analysed the impact of ICT on economic growth in developing, emerging and developed countries. The sample base comprised of 59 countries within the period of 1995 to 2010. The panel data regressions confirm the positive relationship between ICT capital and GDP growth. The regressions further revealed the statistically significant differences of the output elasticity of ICT between the three different country groups. The results showed that developing and emerging countries gain more from investments in ICT than developed economies through having fatter estimated coefficients but statistically the proof is not seen. This result questions the macro econometric validity of the leapfrogging through ICT argument as noted by Steinmueller (2001).

Using a relatively new concept in measuring ICT, Rouaski *et al* (2014) researched the effect of ICT on economic growth using a sample of 137 countries of the world sorted index on the information society – Networked Readiness Index (ICT-NRI) and per capita gross domestic income (GDP_{PC}). Correlation analysis was used to study the trend and similarity between the variables involved. Due to the non-linear relationship existing within the variables, the Spearman rank correlation was used to perform the analysis. The results showed a positive strong relationship existing between the two variables. The study affirmed that ICT plays a crucial role in achieving development and growth.

Olawepo and Joseph (2014) investigated the impact of ICT on economic growth with evidence from Nigeria emphasising that ICT has become the major tool for gaining competitive advantage in the operations of most high performing organisations in every economy. The study employed ordinary least squares (OLS) method to analyse time series data from 1979 to 2010. The variable used to represent ICT was telecom and telegraph usage while a gross domestic product (GDP) was used to represent economic growth. The findings of the research show that ICT stands as an important determinant of economic growth. The research was insightful but there were no theories to back up the study.

Neffati and Besbes (2013), researched on ICT-education and economic growth in 22 Arab economies. The study applies the endogenous growth theory to show that ICT and the skills of

the workforce constitute main factors of economic growth. The scope of the study was between 2000 and 2010. The research uses generalised method of moments. The findings of the study show that a country with high opening rate to receive technology and high investment in education improves the work force. The work emphasises that the more diffused technology is absorbed and used in a profitable way, the more growth is realised. The study achieved its objective but didn't justify the use of the GMM method of analysis which was adopted.

Earlier empirical works such as Osabuohien and Efobi (2012) examined technology diffusion and how it leads to economic progress in Africa through the use of descriptive and empirical analyses based on imitator – innovator theoretical framework. The researchers performed a correlation analysis on the various countries in the different sub groups (West Africa, Central Africa, East Africa, South and North Africa) using variables such as ICT import percent of total import, ICT export percent total export, trademarks applications per nationals, research and development expenditure per capita GDP, output per worker. The study found that Africa has not been too involved in technology diffusion. This in turn has an effect on economic diffusion.

Yekini *et al.* (2012), carried out a descriptive study on ICT tools for poverty eradication and economic growth in Nigeria, recognising that ICTs facilitate the creation, storage, management and dissemination of information by electronic means while viewing Poverty as not just material deprivation but also as lack of access to schooling, health care, vulnerability towards external events, or being excluded from decision making processes. The study used data from government policy and available record from newspaper, magazine, electronic media and processing of data obtained from sample population. Steady power generation, flexible ICT policies, ICT tools subsidy were recommended by the study.

Mital (2012) described one of the roles of Information and Communication Technology (ICT) in achieving inclusive growth as currently being implemented in India. The ICT instrument used is the "IT-enabled unique Identification (UID) number" to address the issue of inclusive growth. The framework uses the unique identification numbers attached to each to resident to facilitate speedy opening of bank accounts, quick issuance of passports, efficient administration of the public distribution system for food at subsidised rates to people below poverty lines and efficient disbursal of wages and salaries under the "Mahatma Gandhi National Rural Employment

Guarantee Scheme (MGNREGS)" for assured employment for every household. Here, ICT and UID numbers are used to attain higher standard of living through different welfare schemes.

The UID concept has its advantages as well as its disadvantages. The adoption of this concept by the Government of India is simply a means to encourage transparency, improve the knowledge base of the government about its residents, assures effective planning, and encourages public-private partnership. It helps to facilitate judicial processes, the provision of land records, issuance of birth and death certificates to your door steps. It helps to include the total population and assist in informed decision making. One of the downsides of the ICT unique identification number system which was not emphasised by Mital (2012), to the best of the researcher's knowledge, is that there could be viral attacks which could harm the database systems and there is a risk of alteration of the data by computer hackers.

In terms of dynamic panel data analysis, Andrianaivo and Kpodar (2010) researched on ICT, financial inclusion and growth with evidence from African countries. The paper studied the impact of ICTs – mobile phone rollout, fixed telephone penetration rates and cost of local calls as well as financial inclusion – number of deposits , bank branches and Automated teller machines (as channels) - on economic growth in some African countries within the period of 1988 to 2007. To account for endogeneity issues, the advanced panel data method - GMM was used to estimate the impact. The results showed confirmed that ICT contributes significantly to economic growth and ICTs consolidate the impact of financial inclusion on economic growth. The research achieved its stated objectives but the scope of the analysis was limited to economic growth and did not touch inclusive growth.

In terms of a unique methodology of analysis, Kuppusamy *et al* (2009) investigated the ICT investment that mattered most to economic growth between the private or public in Malaysia. The research variables comprised of ICT investment carried out by the public and private sectors in Malaysia for the period of 1992 – 2006 using the Autoregressive Distributive Lags (ARDL) econometric approach. The results showed that ICT investments by the private sector contributed more significantly to the country's growth compared to investments by the public sector. The result showed that the private sector has adapted well to ICT-based policies implemented in the country in the previous years. The results also attested to the fact that the Malaysian economy is driven by the private sector, especially by the manufacturing industry. The research

recommended that sustainable economic growth could be achieved through more concerted efforts to escalate ICT diffusion in the country. The study seemed to have achieved its stated objectives but the data period of 1992 to 2006 which is 15 years is insufficient for a normal probability distribution to ensure that the result is unbiased.

Moradi and Kebryaee (2009) studied the impact of information and communication technology (ICT) on economic growth in selected Islamic countries. The study emphasised that ICT is one of the key factors accountable for growth differentials across countries. The study explores specifically, the impact of ICT investments on economic growth in a cross section of 48 countries within 1995 to 2005 using panel data analysis. The steady-state income regression and economic growth regression were specified and estimated; three ICT indexes were used to test the model – network index, ICT usage index and ICT opportunity index. The findings were in line with other works that proposed that ICT contributes to economic growth. It was recommended that information availability should be taken seriously, ICTs should be applied to national education plans, and ICT infrastructure should be supported financially.

Jalava and Pohjola (2007) took a quantitative look at electricity and ICT as the engines of economic growth in Finland (one of the leading information societies). The result shows that ICT's contribution to GDP growth between 1990 and 2004 was three times as large as electricity's contribution between 1920 and 1938.

ICT plays a crucial role in delivering inclusive growth. The United Nations Economic and Social Council Report (2014) grouped the impact of ICT on the human development as well as economic development: the systematic impact and the Policy-making Impact. The systematic impact consists of the economic, social and the environmental impacts. The economic impact focuses on the promotion of globalisation, international trade, and the consumption patterns. The social impact of ICTs is viewed from the perspective of freedom of expression and association (Deshpande, 2011).

The impact of ICT investments on economic growth was researched by Khuong (2004) for a cross-country analysis. The research examined 50 major ICT spending countries, which together account for over 90 percent of the global ICT market. The methodology utilised were the ordinary least squares (OLS) for 10 years (1990 - 2000) and instrument variable (IV) regression.

The OLS showed significance at 1 percent level and IV regression showed significance level at 5 percent. The results of the study indicate that ICT is a significant determinant for the variation in output growth across the 50 economies during the period of interest (1990 - 2000). Furthermore, it was seen that the key determinants of the variance of ICT contribution to growth across economies include institutional quality, education, openness and English fluency. The result shows that ICT boosts efficiency – a higher level of ICT capital stock per capita allows an economy to achieve a higher growth rate given the labour and capital inputs. The study properly accounted for the qualitative data by using IV regression but the sample size for the OLS method was very small (10 years) and could lead to a misleading result because of the law of large numbers (Central Limit Theorem) to get a normal probability distribution.

Nirmala *et al* (2012) examined the role of information and communication technology on economic development of in Entrica (North East Africa) in a descriptive study. It was expressed that the presence of ICT has carved out an alternative path to development. The study gave a brief history of the internet, the profile of the country from the colonisation age to the post-colonisation age, explained how ICT could assist in getting rid of poverty, and went ahead to suggest workable ICT policies. Some of the recommended policies in the study were to reduce the cost of acquisition of ICTs, the creation of telecenters for African goods and services to increase turn-over rates. The study seemed rich in content but lacked the usage of scientific methods such as empirical and statistical check towards achieving its results.

ICT is responsible for the concept of "Internet of things". The internet of things (IOT) is an ICT framework with a goal to harmonise information. The IOT is a platform for linking people and businesses together through innovative applications and services that will further reduce inequality provide increase in income for enterprises, reduce information asymmetry and so on.

In terms of work specifically on human development, Bankole *et al.*(2011) studied the impact of ICT investments on human development in terms of the four dimensions of ICT investments – hardware, software, internal spending and telecommunication investment while human development components were Standard of living (GDP per capita), education (literacy and school enrolment) and health (life expectancy). The data used was for 51 countries across high, middle and low income countries (1994 - 2003) sourced from ITU (telecommunication investment), United Nations - UN (HDI) and WITSA (hardware, software, internal spending)

databases. The methodology used was the three stage least squares (3SLS) to estimate the system of structural equations because of the presence of endogenous variables in the model. The findings showed that ICT investments in terms of the four dimensions have various impacts on the components of human development which are relatively different for high, low and middle income countries. The study seems robust, however, the study used GDP per capita to measure standard of living which does not truly represent standard of living.

Kuyoro *et al* (2012) in a descriptive study, described ICT as an effective tool in human development in terms of ICT, human development and the digital divide; ICT, empowerment and participation; ICT and health; ICT and education. The conclusion and recommendation were aimed at reducing the digital divide. The descriptive research seemed elucidating but has no fact from data and statistical analysis as evidence for the statement of problem.

The role of ICT in skilled manpower development through vocational technical education among higher institutions in Cross River state, Nigeria was investigated by Ben and Ashang (2013). The study used structured questionnaire to elicit information from 2,420 respondents from which 2,210 were vocational education trainees and 210 were vocational educators. The analysis done was mean and standard deviation and the independent t-test statistic to test the null hypothesis. The results showed that ICT has a significant role to play in skilled manpower development.

In terms of other important determinants of human development, Shuaibu and Oladayo (2016), explored the determinants of the human capital development in 33 African countries (2000 - 2013) using panel data analysis. The analysis predicated on Sen's capability approach that was modified following Binder and Geogiadis (2011) to account for the role of health, infrastructure and institutions as potential drivers of human capital development. The determinants used were public expenditure on education and health, institutions, infrastructure – ICT adoption. The methodologies used for the study were correlation analysis, co-integration test, and causality tests. The findings showed that HCD has a stable equilibrium relationship and all the variables had a long term relationship.

The second goal of the sustainable development goals (SDG) enacted in 2015 is to end hunger, achieve food security, improved nutrition and promote sustainable agriculture in the world. To achieve this goal, strategies would have to be put in place by countries especially in the

developing part of the world to meet up the 2030 deadline. To achieve sustainable agriculture in this modern age, the application of Information and Communication Technology (ICT) cannot be under-utilized in terms of smoothening of the value chain components' interaction.

For economic, human, social development and inclusive growth, agriculture plays a significant role in most less-developed and developing countries. Agriculture faces a range of modern and serious challenges, particularly in developing countries exposed to price shocks, climate change, and continued deficiencies in infrastructure in rural areas. Adequate dissemination of detailed information is a necessary condition for improvement of all areas of agriculture (Zhang, Wang & Duan, 2016). Some of the opportunities provided by ICT are full information for product pricing, enabling the collection of agricultural data more efficiently, improving soil testing techniques, improving marketing (e-commerce), easy sorting and record keeping, and so on.

Despite the fact that studies have shown e-agriculture increases total agriculture output in developed countries and the fact that West Africa has the required labour to carry out such great agriculture exploit coupled with one of the highest arable fertile land for growing crops, Nigeria still relies partly on the importation of some agricultural products to combat food insecurity. Many studies in relation to information and communication technology on agricultural productivity have been conducted in Nigeria, but few of them have attempted to provide a comprehensive review and analysis of different information dissemination models and their effects on agricultural productivity in Nigeria using quantitative secondary data. Hence, this study intends to determine the effect of ICT on agricultural productivity in Nigeria.

IFPRI (2002) highlighted some of the already existing uses of ICTs could be used as an effective medium to harness this potential as applied by developed & developing countries. Zimbabwe (e-Hurudza phones), India (Reuters Market Light), Zambia (prepaid voucher, MRIAgro), Kenya (M-Pesa, iCow), Ghana (mFarms) have made use of ICT innovations and have observed and witnessed increase in productivity. India for example; the Reuters Market Light (RML) has improved farmers' productivity by 14-16 percent with farmers selling even more profitably (IFPRI, 2002).

ICT found its way into West African territory few decades ago. Its dominance and influence on the economy of the country cannot be overemphasized. Research has shown that ICT has the

largest market in West Africa with Nigeria among the largest individual market among others (Ayo *et al*., 2010) capitalizing on her giant population. ICT is widely embraced and acceptable due to the availability and affordability of its infrastructure, which is springing up fast (Seyed and Seyed, 2012).

World Bank Report (2009) states that there was a 1.3 percent growth increase with every 10 percent rise in the speed of internet connection. General Purpose Technologies (GPTs) as referred to as by economists (Atkinson, 2009) cut across all sectors of the economy and are known to have practical usefulness in those sectors. ICTs have been found to increase productivity and output, reduce cost of transportation and many other benefits. Rational thinkers as human beings would prefer to engage in activities that would yield highest levels of utility. This makes ICT a more preferred hand - on tool for the developed and developing economies.

ICTs have inclusive advantage accumulation, information storage and dissemination; makes things easier and faster (Chisita, 2010). Mobile technology could be used to overcome problems related to physical distance and mobility of people, allowing the enlargement of areas of practices and maintain connections outside the immediate space of their homes, work, other local areas and increase access to timely and relevant information (Ling and Pedersen, 2005; Asongu *et al*, 2016). The constant increase in globalization trends and integration of markets has intensified competition and efficacy in the most sectors of the international economy, and has brought unique opportunities to include more smallholders into supply chains. With the rapid ICTs, data and information can be effectively generated, stored, analysed, disseminated and used to support labour in communities to improve productivity and sustainability in developing as well as developed countries.

The relationship between ICT and agricultural sector productivity have been explored using primary data source which involves the use of questionnaires for data collection (Ogbomo and Ogbomo, 2008; Hassan *et al*, 2011; Chukwunonso, *et al* 2012; Ramli *et al*, 2013; Okwusi *et al,* 2009). Nwabueze and Ozioko (2011) put forward that ICT has been proven to be the engine of growth in the 21st century. It has found its place in many sectors in West African economies and its importance cannot be over emphasized.

The effect of utilization of ICT for agricultural transformation on socio-economic characteristics of farmers in south-eastern Nigeria was carried out. Structured interview was administered on 270 respondents in the study area. Data analysis was by the use of multiple regressions. Findings revealed that Age, education, marital status and income significantly influenced utilization of ICT for agricultural information by farmers. It was recommended that efforts should be made by Federal, State and Local Governments to provide adequate ICT resources in both urban and rural areas (Okwusi *et al, 2009*).

ICT provides pricing information, production and agriculture extension and demand information through knowledge availability, (Awuor, *et al,* 2013). Pricing Information here refer to Information on selling such as market availability, retention price, selling price, dealers, ware house; production and agriculture extension information include funding, credit, awareness about crops, pollution control, pest and disease control, new farming techniques, quality enhancement. Demand information consists of crop variety, land use, soil health, soil nutrients, requirement, irrigation, Weather report. Knowledge availability includes dedicated website, emails, SMS, voice calls/customer care agents, telecenters, e-learning/training. Some other ways in which ICT can help tackle key challenges in agricultural value chain development, are pricing and weather information systems, applications to help buyers manage transactions with the thousands of small – scale farmers who supply to them, mobile banking and apps that facilitate quick payments, initiatives to expand the reach of farm extension services through phones, radio, internet, personal computers, or text messaging (SMS) campaign for enabling environment.

Anastasios et al (2010), envisages ICT from the investment point of view, on the implementation of ICT into agricultural extension. The feasibility of implementing ICT into the agricultural sector can be checked by using the Net Present Value (NPV) criterion to judge. According to the study, anything related to ICT is modern and interesting and it would help growth as it helps farmers with various data. ICT is seen as an investment tool in any economy which can be used for rural and agricultural development. According to the study, when uncertainty sets in on what methods or tools to use, ICT can be the solution for that uncertainty by making use of the cost-benefits analysis to make that decision. The study also utilised real options theory to talk about how to make ICT investments. The study concluded that making ICT investments in the agricultural sector is feasible.

Brynjolfsson (1993) analysed and illustrated the effect of the ICT in firms in terms of a cost and benefit analysis as a paradox which include; measurement problems in firms especially manufacturing firms as the stock of ICT would most likely not be an easy measure, time lags from adjustments and between costs and benefits because pay offs from ICT investments may take some time before they become noticeable, redistribution of benefits as it may be beneficial but to some sets of firms and not to some others and the mismanagement of ICT. Triplett (1999) also agrees that information though not quantitative increases level of output using the US as an example. Information is an important production input and is very vital in all market mechanisms

Kyem (2012) proposed ICT as a paradox being, while ICT promotes development in sub-Saharan Africa, relying on it could also impede development in this region. An Observation of the use of ICT from a rational approach shows the various differences between when ICT is used in developed countries as against the developing countries. Furthermore, it was noted that ICT adds more value to developed economies than it adds to developing economies and for ICT to produce a positive impact in developing economies, the citizens should not be treated as passive but rather as active citizens, willing to learn and adopt new technologies. In Kyem's study, technology adoption in the developed economies was a gradual process that evolved. In conclusion, Kyem recommended that sub-Saharan countries should be left to evolve and assimilate the technological innovations that would lead to development at their own pace. Hence, developing economies should not be too quick to deploy ICT innovations that would thereafter make them solely dependent on the developed countries.

Mpofu and Gono (2016) critically explored the various factors that encourage ICT adoption in the small and medium firms sector in countries in the Southern part of Africa. The study built on previous literature which focused on issues related to ICT adoption processes among small and medium firms operating in Botswana, South Africa and Zimbabwe. The ICT adoption theories that were utilised by the research were the Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI). The investigations in previous work in literature, which highlighted the influence of several key factors that include government role, social networks, environmental, Organisational, Technological and owner-manager were also used as a guide to carry out the research. A quantitative as well as a qualitative research design were chosen to carry out the study. The results which was premised on over 60 semi-structured interviews with participants

from case studies in the small hotel industry in South Africa, Botswana and Zimbabwe highlighted the influence of several key factors that include government role, environmental role, Social networks role, technological role, organisational role and owner-manager role (GESTOO) on the ICT adoption process of SMEs. However, the initial results of the study did not give explanations for the inter-relationships existing between the identified ICT adoption factors.

Sadowski (2014) carried out an impact regression analysis on information and communication technologies (ICT) on small- and medium-sized firms and enterprises (SMEs) with a preference to develop and exploit strategic opportunities. According to the researcher, Prior investment in ICT infrastructure is expected to lead to follow-up decisions to adopt new ICT services, but there is no assurance that SMEs will definitely use emerging strategic opportunities in adopting these services. In this light, the paper examines whether or not the adoption of advanced ICT infrastructure and advanced ICT services by SMEs has been inter-related and was depending on number of firm-specific, market-specific and location-specific factors. In contrast to previous studies, the focus is on the extent to which the adoptions of ICT infrastructure and ICT services have been driven by anticipation about open access by SMEs. Open access was captured as expectations by these companies about cheaper prices in the future, better quality of service and more competition on the infrastructure. The research uses collated data from a survey undertaken among 247 small and medium firms on different industrial parks in Netherlands (February, 2011). The estimates of the survey show that SMEs value open access factors highly with cognisance to their choice to always opt for new ICT infrastructure and new ICT services.

In Netherlands, ICT adoption in the health sector was investigated in a descriptive study by Plomp *et al,* (2011). The focus of the study was on an inter-organisational ICT in primary care facilities. As posited by the researchers, inter-organisational ICT enables and facilitates this collaboration, but the implementation of such information systems is still meagrely analysed. The study utilized a survey instrument among 49 general practitioners' practice in the Netherlands (2009 – 2010), which were queried on the adoption of different variety of inter-organisational ICT, such as the "exchange with out-of-hours services" and with other "primary" and "secondary care providers". The results showed that the adoption of inter-organisational ICT is not significantly related neither to personal or organisational traits of the general practitioner's

practice, nor to characteristics or traits of their patient population. The study seemed not too statistically robust

The gaps found and implications for further studies from literature are to the best of the researcher's knowledge – few works exist on ICT adoption and inclusive growth; no ICT adoption and human development research focus particularly on West Africa considering the combination of three major components of ICT adoption investment in telecoms, mobile technology and internet usage; no work on inclusive growth whose model considered the inclusion of a lagged dependent variable with the addition of the unique control variables as used by this study.

2.4. ICT Adoption Pass-through Framework – Application of Theories

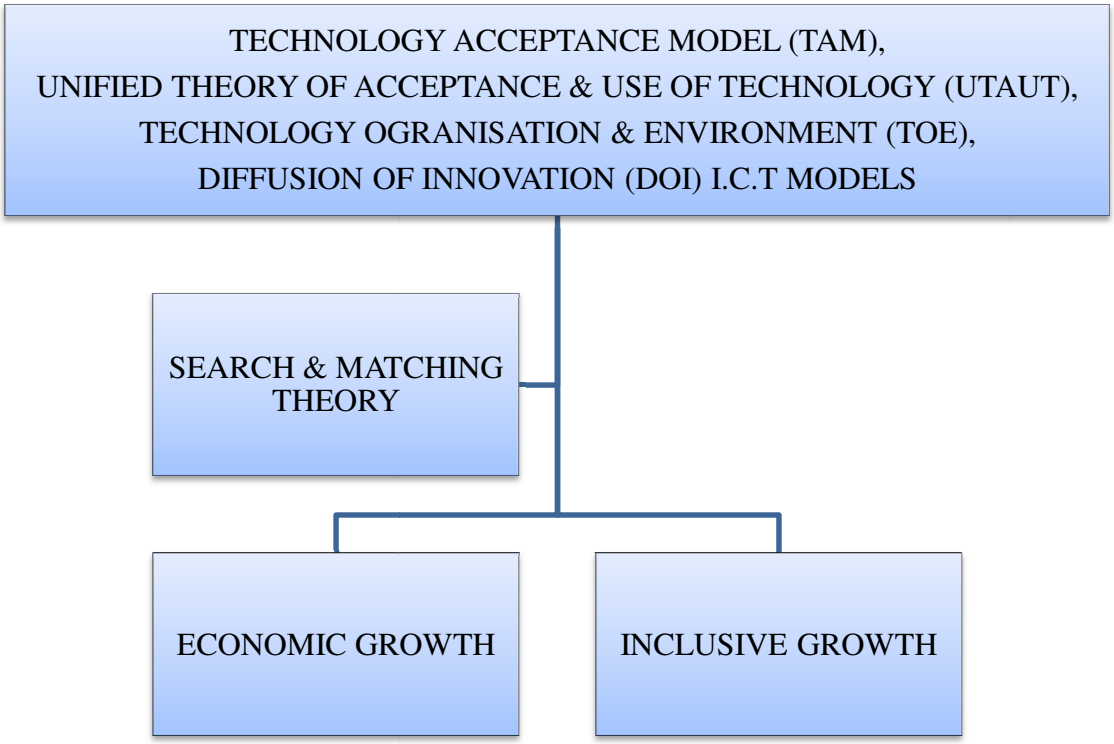


Figure 2.1 Schema showing the ICT Adoption Pass-through to Economic and Inclusive Growth

Source: Conceptualised by the researcher from the Issues in the Literature

Figure 2.1 shows the transmission mechanism from ICT adoption to inclusive and economic growth. The transmission is initiated from the various theories (reasons) on how and why a new

technology is adopted by an individual, firm, country- in this case; the ICTs are internet, mobile phone technology, then utilised by the population to reduce the information asymmetry and Information variance between the different users at the various sides of each value chain that exists in all the sectors in an economy. This in turn will increase productivity overtime and therefore, economic growth. Inclusive growth is achieved through the increased participation of the labour force in the various economic activities; which is in line with the definition of Inclusive growth; that is, creating equal opportunities for all in an economy. This transmission pass - through could be applied to the labour market, capital market, all sectors of the economy including education sector, health sector, agriculture sector, and so on.

2.5. Other Models on ICT Framework

Certain researchers have come up with different frameworks to capture how ICT adoption can translate into inclusive growth, among them are: UNESCO (2014), Johnson (2016), Harris (2004).

a. UNESCO's Inclusive Growth Web

The United Nations Economic and Social Council (2014) highlighted and therefore categorised the potentials of Information and Communications Technology into:

- Increasing efficiency in the economic and social progress
- Improving Stakeholders collaboration
- Increasing access of individuals, firms and government to quality information.

Below is the schema showing the potentials of ICTs by UNESCO

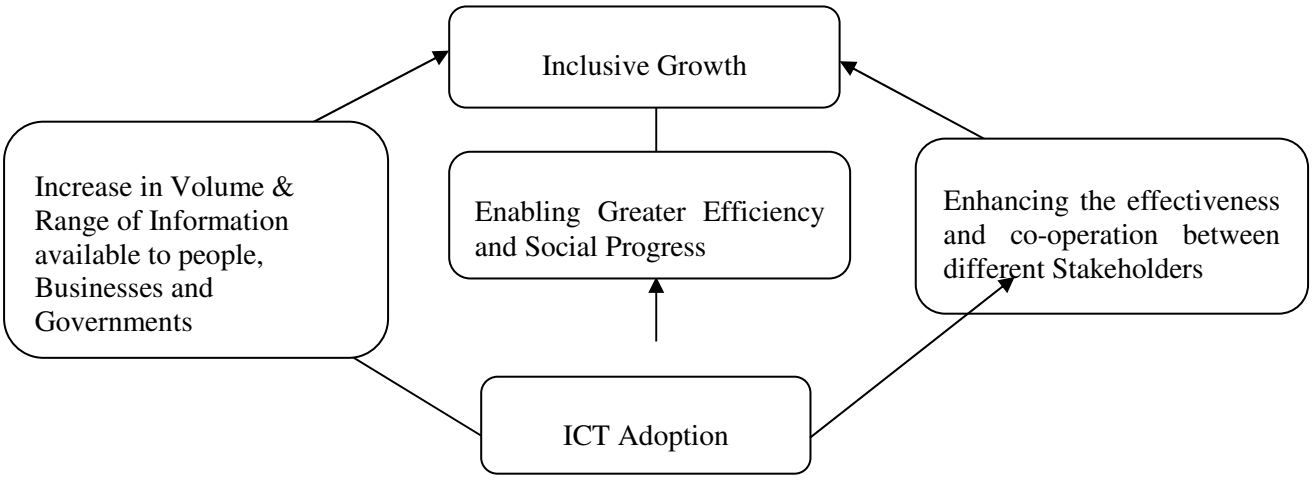


Figure 2.2: Schema showing the Information and Communication Technology potentials

Source: Adapted from Johnson (2016)

b. **Johnson's ICT – Inclusive Growth Pyramid**

Johnson (2016) emphasised on the categorisation of countries based on their level of investment in ICT and level of usage of ICT and how their investment contributes to inclusive growth. The research showed that all countries in the world could be categorised into three; ICT empowered economies (ICTEE), ICT adopting economies (ICTAE) and ICT deficient economies (ICTDE). Johnson discovered that countries that are ICT empowered are characterised by High level of Inclusiveness, vibrant ICT infrastructure, low inequality, low unemployment rate, high enrolment rate, large human capital development, and largest ICT investment. ICT adopting economies are characterised by moderate level of inclusiveness, relatively less robust ICT infrastructure, relatively high poverty and inequality rate, relatively high unemployment rate. ICT deficient countries are characterised by poor level of inclusiveness, huge digital divide, and low human capital investment, poor investment in ICT infrastructure, poor ICT infrastructure, very high unemployment and inequality rate. Figure 2.3 below shows the ICT- inclusive growth pyramid.

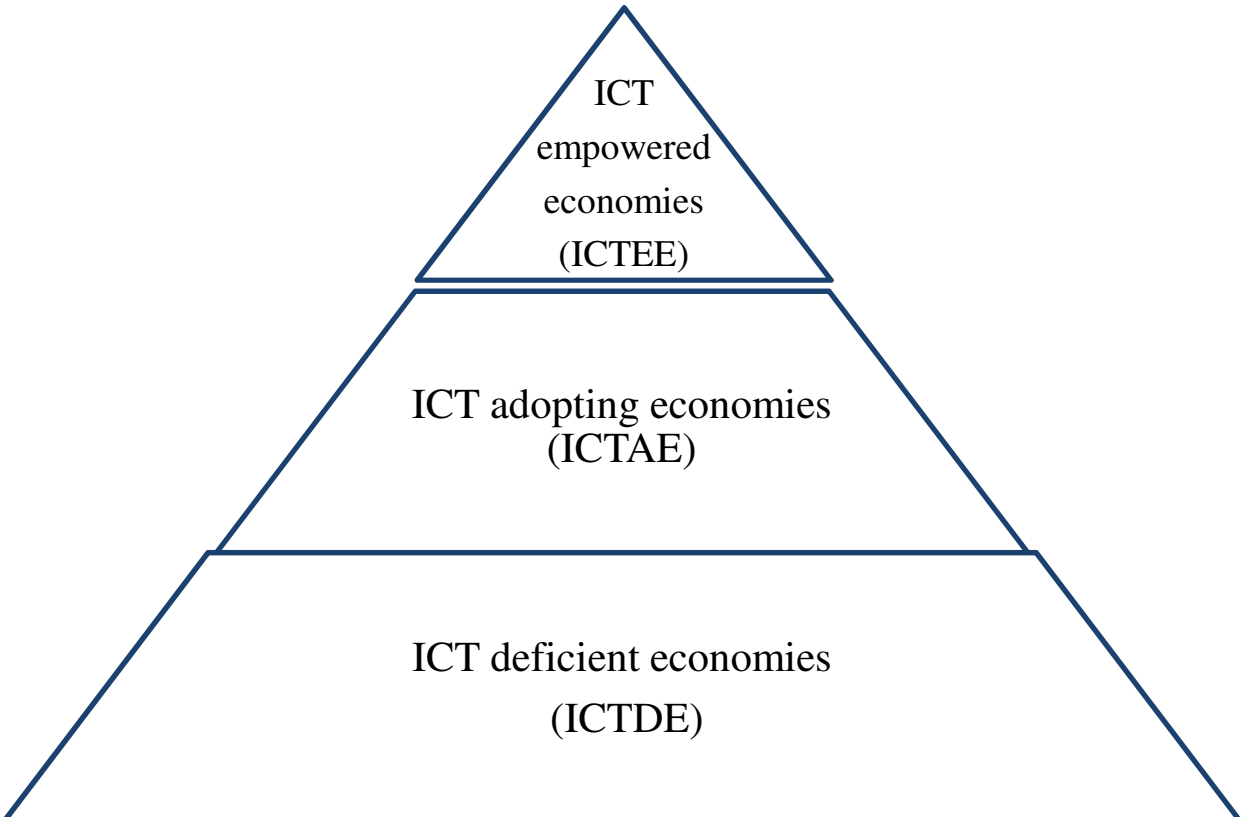


Figure 2.3: ICT - Inclusive Growth Pyramid

Source: Adapted from Johnson (2016)

The ICT- inclusive growth pyramid also shows that the amount of ICTEE countries are relatively few compared to ICTAE countries and ICTDE countries are the largest in size. Examples of ICTEE countries are United States of America, Japan, and South Korea. Examples of ICTAE countries are India, Kenya, while examples of ICT deficient economies are Nigeria and Zimbabwe.

c. Pakistan's Strategy for Information and Communication Technology

Figure 2.4**:** Chart showing Pakistan Strategy for Information and Communication Technology. Source: Adapted from Hameed (2006).

Pakistan's government operates a system which uses ICT as a producing sector and as an enabler. ICT as a sector focuses on creating employment, training and development of human resources, incentives for investors, and so on. ICT as an enabler ensures improving efficiency of planning, executing and monitoring of projects through reduced information asymmetry. ICT is being considered a source of economic growth and faster competitive advantage in Pakistan. The policies and strategy have produced impressive results – with annual software industry Turnover of US$ 70-80 million, Annual IT market of US$ 800 million, Number of IT companies working in Pakistan – 700 companies.

2.6. ICT Adoption, Economic Progress, Human Development and Inclusive Growth

Worthy of note, is the fact that the populace do not need word processing to survive, but they may want efficient ways to share information about livelihood and employment (Hameed, 2006).

ICT for human development is not about the technology but about people using technology to meet some needs, thereby creating time for other things.

Having explained the detailed role of ICT adoption on human development and inclusive growth, the ways it can cause inclusive growth are:

1. **Job Creation** – Investing in ICT as a sector by both the public and private sectors will create job opportunities for people with ICT interests. This investment will be used by I.T firms to expand their capital base to be able to employ more people, open more branches, increase their competitive advantage with respect to international competitive firms, increase their output overtime, and improve Balance of Payment through increased export of ICT services and goods. Pakistan and India have successfully achieved job creation through ICT investment as a sector and an enabler. This will reduce the unemployment rate which in turn could cause reduction in poverty, hunger and attain full productive employment, which are the first, second and eight goals of the Sustainable Development Goals (SDGs, 2016).

2. **Increased Education For All –** Due to the fact that ICT knows no physical or geographical barrier, increased access to education through long-distance learning. ICT creates the opportunity for individuals to access high education standards from anywhere in the world at any time. This helps to reduce the knowledge disparities among different people in different areas, enables ideas to be shared across different groups of people, facilitate reduced cost during knowledge transfer from one location to the other. This can be seen as applied by schools such as Harvard University distance learning programs and firms such as World Bank distance learning courses. This helps to achieve the fourth goal of the Sustainable Development Goals (2016), which is to achieve quality education.

3. **Increased Research and Development for Increased Productivity** –Research and development has been seen to increase the general output and productivity overtime of individuals, firms and Industries. Information and Communication Technologies such as internet facilities, smart mobile phones, computers, grant access to easy and spontaneous Information and knowledge gathering. Such gathered information could increase productivity of Individuals and firms in terms of health care information; real-time Doctor – patient interaction platform, soil

testing techniques for crop production in Agricultural sector, online marketing, expanding of customer base, and so on.

4. **Reduced Queues in Banking Halls to Improve Financial Inclusion -** Financial inclusion advocates for access to financial services by all in an economy. The availability of ICT has made banking more accessible and more convenient, thereby reducing the amount of queues in banking halls. Examples of such application are seen in the mobile apps of banks such as United Bank of Africa, internet banking of Guaranteed Trust Bank for easy and stress-less payment of bills, transfers, and so on, thereby increasing financial inclusion for all in every economy.

5. **Improved Value Chain Interaction -** ICT adoption by the total populace helps to bridge the gap between all the users within the value chains in all the various sectors of every economy through the reduction of information asymmetry. The value chain consists of the typical producer, wholesaler, retailer and customer. Information asymmetry is a term that explains the differences in information available and being shared among the suppliers and the demanders within a particular market (capital market, labour market, goods and services market, Foreign exchange market) in different sectors simultaneously. ICT like the internet, mobile cell and smart phones, problem solving applications on the web guarantee real-time communication with no limitation by distance, location, and so on, which in turn increase productivity overtime creating more time to multi-task and can be a way to achieve inclusive growth.

   ICTs are at the forefront of many innovative activities occurring in West Africa (Asongu *et al*, 2016) such activities include M-pesa in Kenya and other African countries (Kirui *et al*., 2013; Singh, 2012); empowerment of women (Maurer, 2008; Ojo *et al.*, 2012); consolidation of health services (Kliner *et al*., 2013); household management efficiency (Al Surikhi, 2012); bridging of the rural-urban (Chan & Jia, 2011; Qiang *et al*., 2011); enhancement of household opportunities for business (Mishra & Bisht, 2013; Ondiege, 2010) and elimination of wastes in agriculture as well as supply- and demand-side obstacles (Aker & Fafchamps, 2010; Muto & Yamano, 2009).

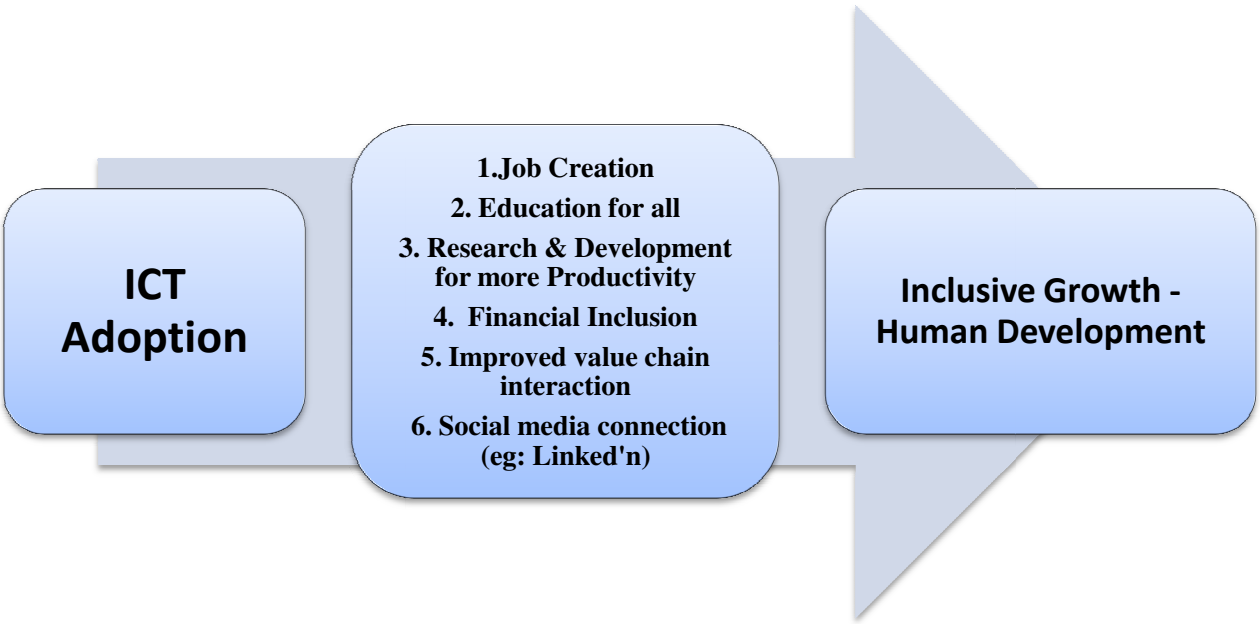


Figure 2.5: How ICT Adoption Transmits to Human Development and Inclusive Growth

2.7. Limitations of ICT Adoption in West Africa

Certain factors limit and slow down the adoption of ICTs by West African countries. These factors among others are: cost of adoption, level of literacy and language disparity, low ICT investment and infrastructure, low electricity and energy supply, anti-globalisation ideology (Parida *et al*, 2010; Talebian, *et al*, 2014).

2.8. The Down-Side of ICT Adoption in West African countries

ICT has its advantages as well as disadvantages. Having highlighted the models, benefits and limitations, some of the backdrops of ICT adoption are: ICT or process automation threatens the availability of jobs; ICT creates room for organised criminal activities such as hacking and cybercrime activities which could lead to loss of huge amount of money due to online fraudulent activities (Johnson, 2016).

CHAPTER THREE

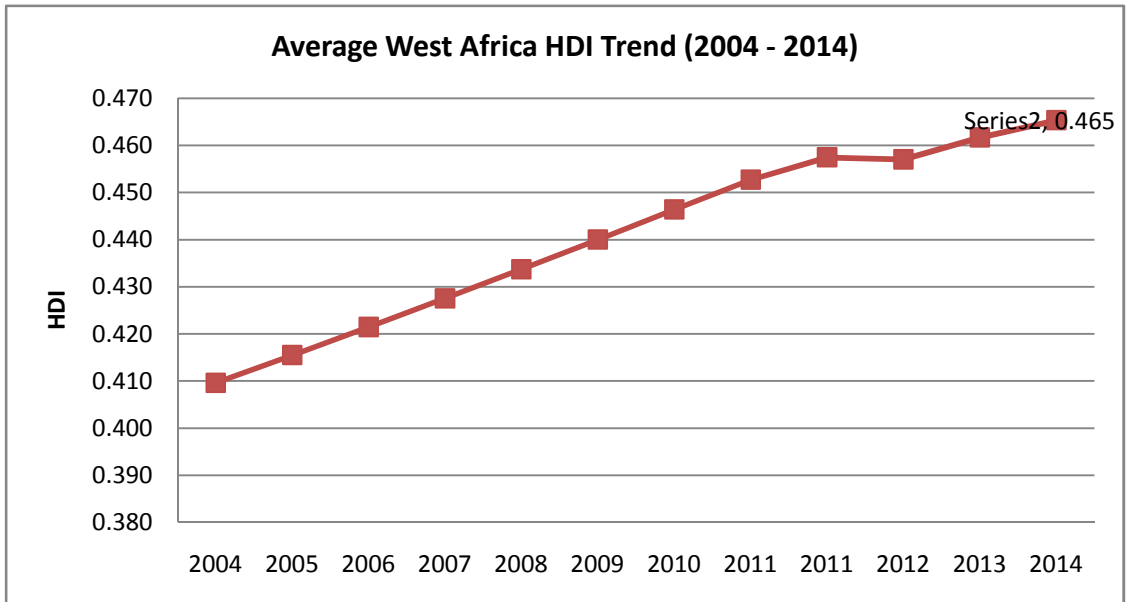
STYLISED FACTS

This chapter examines the trend of the necessary variables in the data set between Information and Communication Technology (ICT) adoption and human development. The variables contained in this chapter are Human Development Index, GDP per capita, number of internet users, mobile cell subscribers, fixed telephone lines and investment in telecoms. The 15 selected West African countries are: Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sierra Leone, Senegal and Togo. The data is sourced from World Bank (2016a) and World Bank (2016b).

3.1. Human Development Index

Human Development Index (HDI) is a measure of human development which represents inclusive growth. It is a composite index which measures the average achievement in the three basic dimensions of human development – health, education and decent standard of living (UNDP, 2015). The values of the HDI lie between: 0.1 to 1.0. The higher the estimate of the human development index in a country, the higher the human development in that country and vice versa.

The maximum and minimum values show that the human development index grew as high as 0.65 which was found in Cape Verde at 2014 and as low as 0.28 in Niger as at 2004. The trend of the average HDI for West Africa has been increasing almost consistently until it was interrupted in 2011 and remained at the same level till 2012 before it experienced a further increase. Below is the trend of the average HDI for the period of 2004 to 2014.



Data Source: UNDP (2015)

Figure 3.1: Average Human Development Index of West African countries (2004 - 2014)

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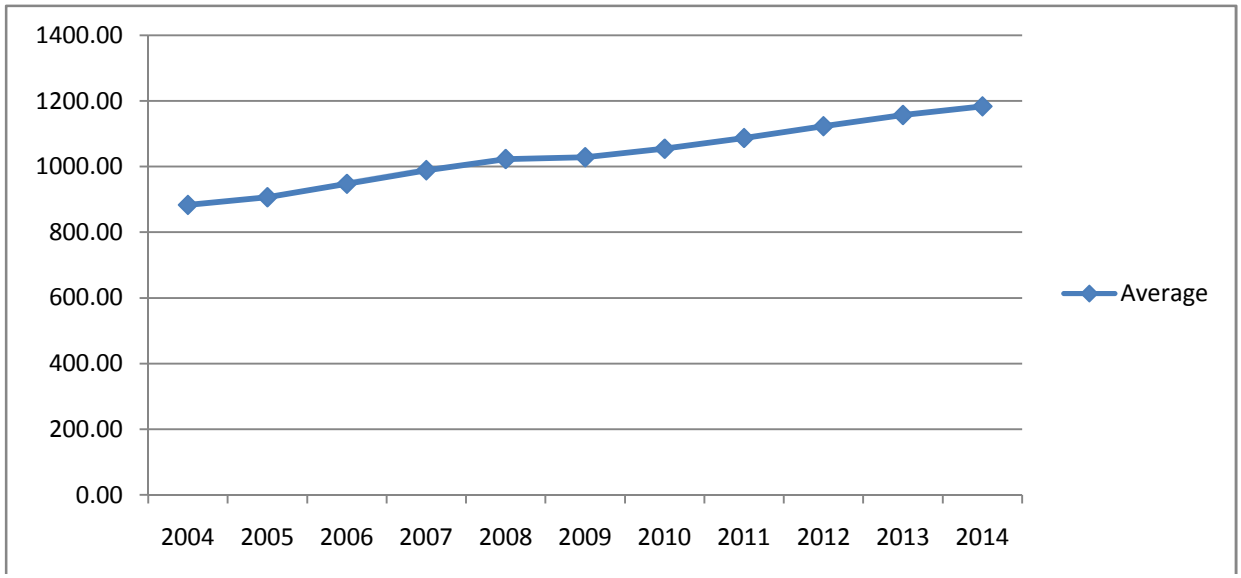
3.2. Gross Domestic Products per Capita (GDPPC)

The real gross domestic product per capita is one of the generally accepted measures of economic growth. It is derived from the division of the GDP of a country by the total population. It shows the amount of GDP share a citizen will get (GDP per head) measured in US$ (constant 2005). From Fig 3.2 below, Cape Verde has the highest GDP per capita followed by Nigeria, followed by Ghana, Cote d'Ivoire, and so on. The country with the lowest RGDP per capita is Liberia.



Data Source: World Bank (2016a)

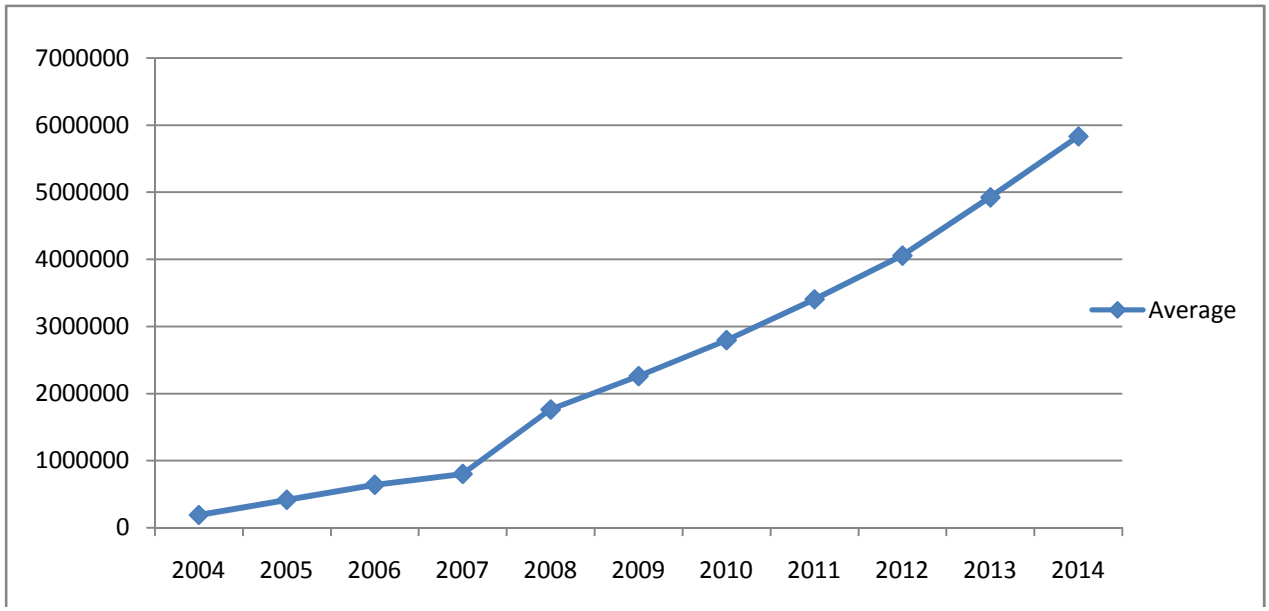
Figure 3.3: The GDP Per Capita ($US) of West African countries (2004- 2014)

The value of the GDP per capita is strongly determined by the population and the real GDP. The statistics also show that between the periods of 2004 to 2015, the GDPPC seemed to be relatively increasing overtime. This could be as a result of the rising rate of population compared to the relatively low rising rate of the GDP. A country like Nigeria is seen as the biggest economy in Africa, but because of their rapidly increasing population, the GDP per capita is relatively low compared to Cape Verde.

More specifically, Cape Verde as at 2004 had a GDPPC of $2498 and was consistently increasing to $3535 by 2014. Nigeria came next having $1851 as at 2004 and $2548 as at 2014. Ghana came next having $1063 as at 2004 and $1670 as at 2014 (alongside Burkina Faso). The least countries in terms of GDP per capita for that period (2004 to 2014) were Liberia with $272 by 2004 and $376 by 2014. Niger had $327 by 2004 and $385 by 2014.

3.4. The Number of Internet Users (INTUS)

Although internet usage came late to West Africa, the statistics show that Nigeria is the highest in terms of number of internet users.



Data Source: World Bank (2016a)

Figure 3.3: The Number of Internet Users in West African Countries (2004 - 2014)

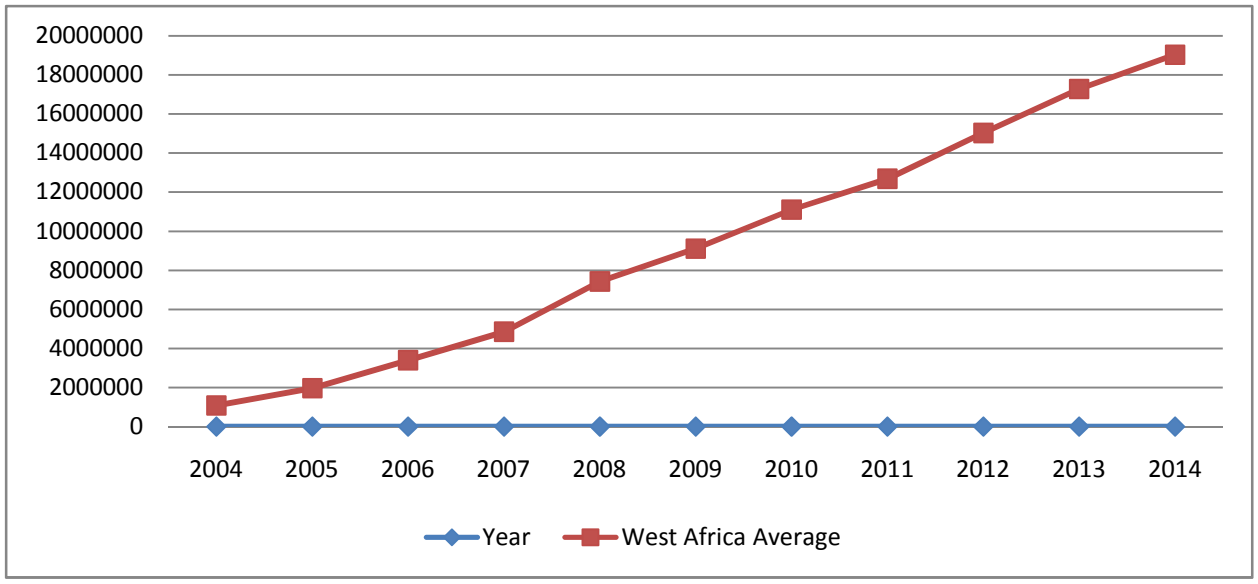
The number of internet users shows the total number of people in a country with access to internet facilities to surf the web for various reasons. The number of internet users was derived from the multiplication of the number of internet users (per 100 people) by the total population and then divided by 100.

Figure 3.3 shows that Nigeria is the highest in terms of internet usage, followed by Cote d' Ivoire while Guinea Bissau has the lowest internet usage. Nigeria as at 2004 had approximately 1.8 million internet users and as at 2015 had approximately 86 million internet users. Cote d' Ivoire had 151,193 internet users as at 2004 and approximately 4.8 million internet users by 2015. Guinea Bissau on the other hand, had 25,889 internet users by 2004 and as at 2015, 65302 internet users. It is important to note that the population of the country of interest also accounts for the number of internet users.

3.5. Mobile Cellular Subscribers (MCS)

Mobile cellular subscribers are the total subscriptions to a public mobile telephone service (World Bank, 2016a). Nigeria proves to be the giant of Africa in this case by having the largest

number of mobile cellular subscribers – 9.15 million subscribers by 2004, 139 million by 2014; followed by Ghana – 1.69 million subscribers by 2004, 30.3 million subscribers by 2014; followed by Cote d'Iviore– 1.67 million subscribers by 2004, 22.1 million subscribers by 2014. The smallest countries in terms of Mobile Cell Phone Subscribers are Cape Verde – 65,780 Subscribers by 2004 and 616,378 subscribers by 2014. The values of mobile cellular subscriptions increased massively overtime, way higher than the total population due to people's preference to be subscribed to 2 or 3 different networks and service providers at the same time.



Data Source: World Bank (2016a)

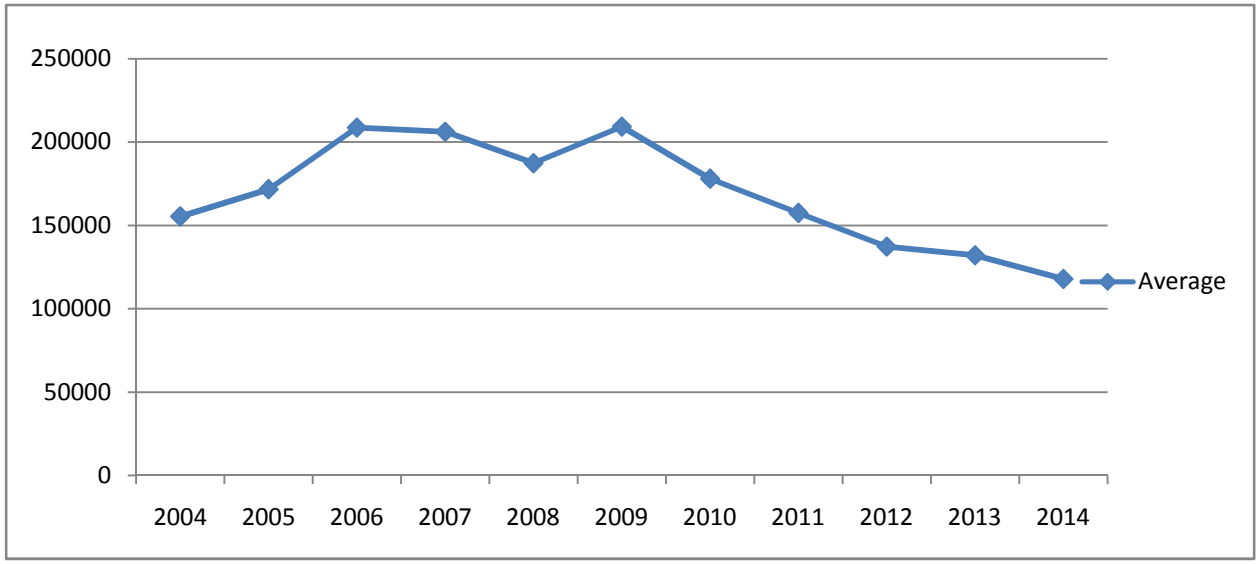
Figure 3.4: The Number of Mobile Cell Subscribers in West African countries (2004 - 2014)

3.6. Fixed Telephone Lines (FXTL)

The overall fixed telephone lines statistics constantly reduced because of the migration of people from fixed telephone lines to mobile cellular subscriptions which is due to the relative portability of the latter compared to the former. Nigeria still has the highest record of fixed telephone lines despite the fact that they reduced drastically from 1.7 million fixed telephone lines by 2005 to 200,000 fixed telephone lines by 2014. This reduction was due to the migration of people from the usage of fixed telephone lines to mobile cell phone users. Mali on the other hand had

consistent increase in fixed telephone lines - from 65,834 fixed telephone lines to 154,417 fixed telephone lines.

However, the countries with the highest fixed telephone lines for the periods – 2004 to 2012 was Nigeria with cote d'Ivoire taking the lead by 276,135 fixed telephone lines by 2012 – 280,000 fixed telephone lines by 2015 and Ghana with 284,000 fixed telephone lines by 2012 and 276,000 fixed telephone users by 2015, while the least country in terms of fixed telephone lines was Guinea Bissau having 9,719 fixed telephone lines by 2004 and 4,844 by 2009 fixed telephone lines.



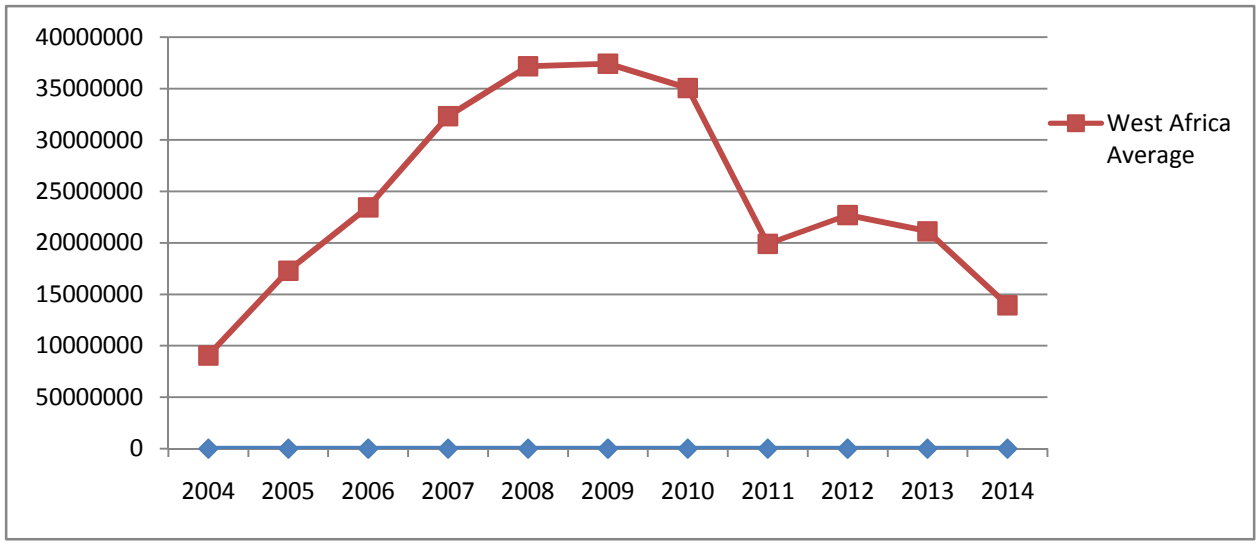
Source: World Bank (2016a)

Figure 3.5: Fixed Telephone lines in West African countries (2004 - 2014)

3.7. Investment in Telecoms (INVIT)

Investment in telecoms embodies the total public and private investment in the telecommunication industry such as infrastructure projects, assets, and so on to provide telecom services to the public (World Bank, 2016a). The investment in telecoms is measured in $US millions for comparative analysis. Below are the charts for the West African Countries for the period of 2004 to 2015.

Statistics show that within the period of 2004 and 2015, Nigeria and Ghana have the largest investment in telecoms industry, while Cape Verde, and Togo. Nigeria had US$1.07billion by 2004, US$2.13 billion by 2011, and US$1.36 billion in terms of Investment in Telecommunication. Ghana's investment in telecoms by 2004 was US$80.6million while by 2014, it was US$151million. Cape Verde as at 2006, had US$16 million, US$23.2 million and US$5.3 million by 2011 as investment in telecoms. Togo, despite the fact of incomplete data update, had investment in telecoms by 2009 being US$44 million; 2014 being US$26 million.



Data Source: World Bank (2016a)

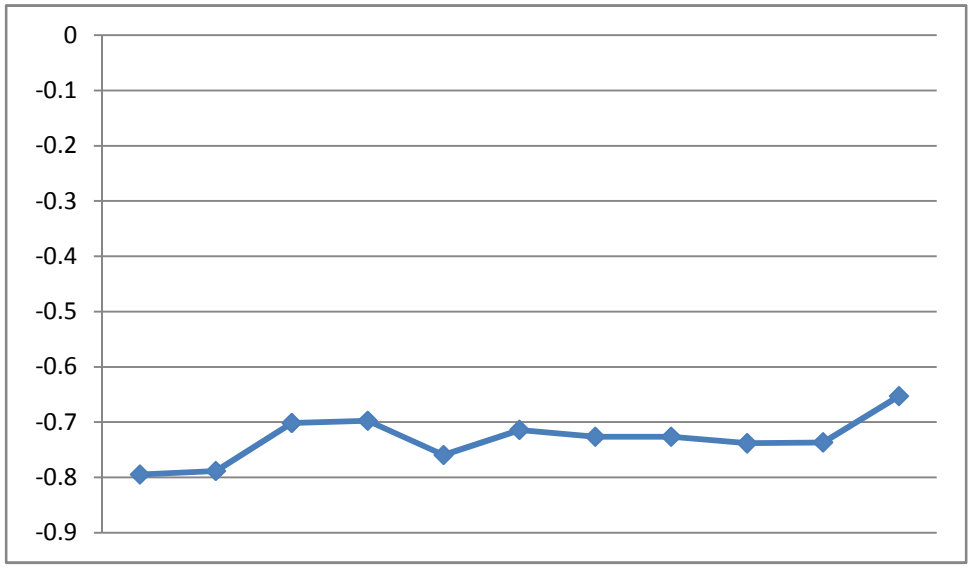
Figure 3.6: Investment in Telecoms ($US) in West African countries (2004 - 2014)

Human development, GDP per capita, number of internet users, mobile cell subscribers, in West Africa was seen to have a relatively increasing trend within the period of interest, while that of fixed telephone lines and investment in telecommunications showed exhibit of a downward v - shape and downward u – shape respectively.

3.8. Rule of Law (Rule)

'Rule' represents rule of law which captures perceptions of the degree to which economic agents have confidence in the legal institutions and therefore abide by the society's rules, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well

as the likelihood of crime and violence. The estimate gives the country's level on the aggregate indicator, in units of a standard normal distribution ranging from approximately -2.5 to 2.5.



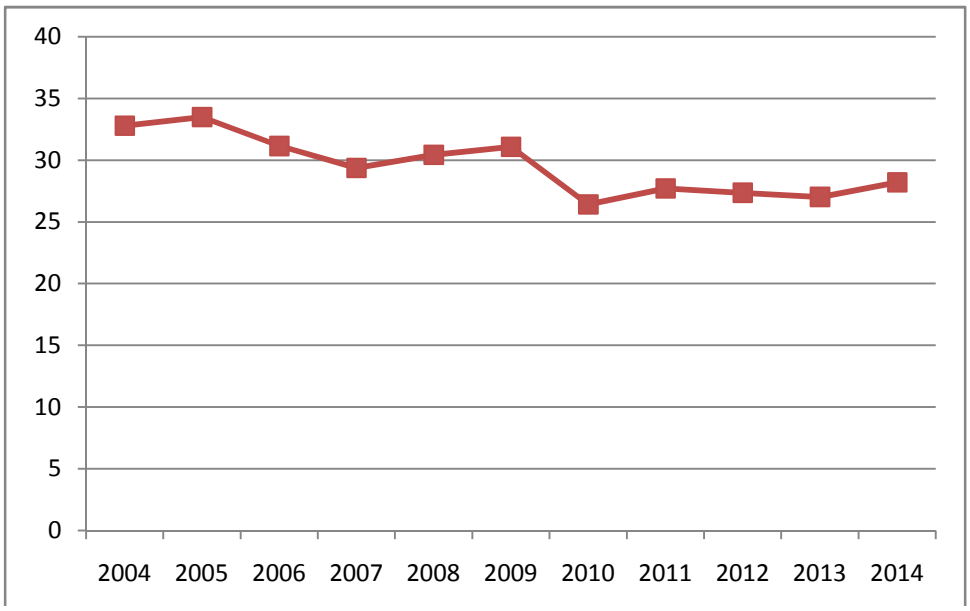
Data Source: World Bank (2016b)

Figure 3.7: Rule of Law (Institution) in West African countries (2004 - 2014)

Rule of law in West Africa has been relatively poor having an average of – 0.73. It had its highest point at 0.59 (2014) attained by Cape Verde and its lowest point at -1.71 (2011) attained by Benin.

3.9. Domestic Credit to Private Sector (Percentage of GDP)

Domestic credit to private sector by banks refers to financial resources provided to the private sector by other depository corporations (deposit taking corporations except central banks), such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises. The domestic credit to the private sector was included as a control variable for the estimation of the final results.



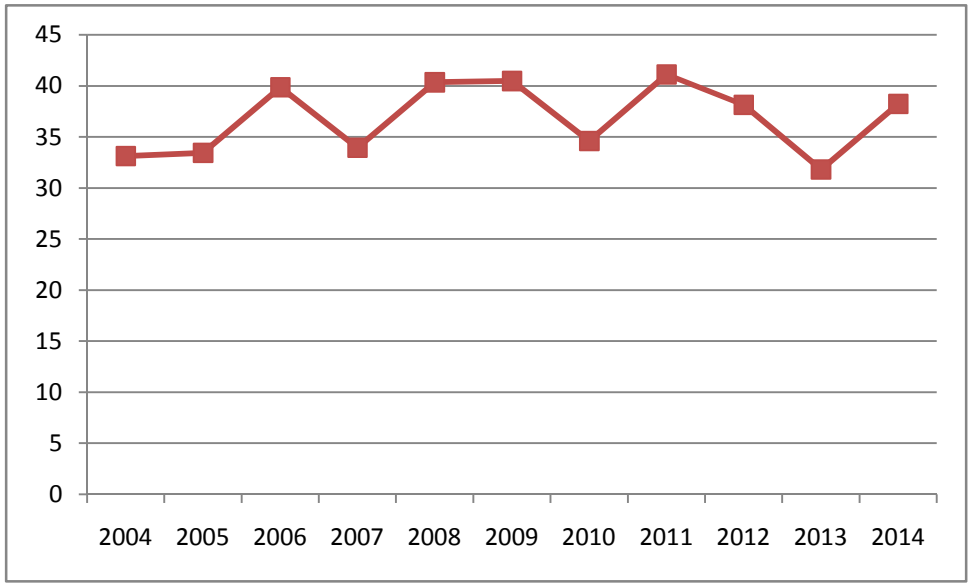
Data Source: World Bank (2016a)

Figure 3.8: Domestic Credit to Private Sector in West African countries (2004 – 2014)

The value of the domestic credit to private sector is strongly determined by a number of variables (major contributing factors like the credit worthiness of the debtors, the monetary policy rate for each country and so on are likely to contribute to this trend). The statistics show that between the periods of 2004 to 2015, the domestic credit to private sector seemed to be relatively decreasing overtime. This could be as a result of the falling exchange rate faced by some of the West African countries like Nigeria, expansion of GDP overtime compared to that of the domestic credit to the private sector the reduction transparency level causing leakages, the reduction in the credit worthiness of the borrowers and so on.

More specifically, West Africa on the average has witnessed the domestic credit to private sector to be 30 percent within the period of interest (2004 - 2014). The maximum value for the period was attained by Liberia (2004) with 227.7 percent while the minimum value was attained by Guinea Bissau (2004) with 4.27 percent.

3.10. Primary School Enrolment Rate (percentage of female)



Data Source: World Bank (2016b)

Figure 3.9: Primary School Enrolment Rate in West African countries (2004 – 2014)

The primary school enrolment rate measures the female pupils as a percentage of total pupils at primary level include enrolments in public and private schools. This variable was used as one of the control variables for the estimation of the final results and analysis of this study.

The percentage of female with primary school enrolment in West Africa has been fluctuating overtime given various heterogeneous reasons. However, on the average the rate has been below 50 percent. In terms of statistics, the average percentage of females with at least a primary school enrolment level of education in West Africa is 46.7 percent. The maximum value of the West African female primary school enrolment rate was attained by Senegal in 51.57 percent while the minimum value was attained by Niger (2004).

CHAPTER FOUR

METHODOLOGY

This chapter examines the theoretical underpinning and the relevant empirical methods of analysis of the research on the relationship between information and communication technology (ICT) and human development.

4.1 Theoretical Framework

Two major theories underpin this study - diffusion theory of innovation (Rogers, 1962) and the Schumpeterian model

4.1.1 Diffusion Theory of Innovation and Schumpeterian Model of Growth

The diffusion theory of innovation explains the process a new idea or product (technology) is adopted overtime. It is mainly used for research and development purposes.

The Schumpeterian model of growth is an extension of the endogenous growth theory. It has three basic determinants of growth within an economy – technology (A_i) such as ICT, socio-economic setting (S_i), including institutions and the conventional growth components (X_i) (Schumpeter, 1991; 2005; Becker *et al,* 2005; Bazhal, 2016).

$$Y_t = f(A_I S_i X_i) \text{ - - - - - - - - - - } (4.1)$$

For which, the major driving force among the conventional growth components is capital accumulation which is dependent on investment (I) being equal to savings (S) in a steady state, and savings are derived from profit made possible by technological change and the socio economic setting around it (Andres *et al*, 2016). On the other hand, the socio-economic setting is dependent on the resources available, technology and the level of development.

The endogenous growth model was based on these three premises (Romer, 1990)

1. Technological change which is characterised by increasing returns to scale, is the main determinant of economic growth
2. Technological change is determined by intentional actions taken by people who want to experience growth as a response to market dynamics
3. Technology is non - rivalry, non - convex and non - exclusive

Technological change (A) according to the endogenous growth model arises from intentional investment decisions made by profit – maximising agents such as firms, industries, economies, and so on. Technological change informs the right combination of the labour and capital components in every production process. However, the Schumpeterian technological change is sporadic due to five initiators: "Introduction of new ideas, requiring technological know-how; Introduction of new production techniques requiring funds (credit); Discovery of new sources of supply; Discovery new markets; Change in the structure and organisation of the industry involved".

The type of technology emphasised in this study is Information and communication technology (ICT). The adoption of ICT improves the productivity in the combination of labour and capital and contributes to innovation. The model suggests that low levels of human capital (through low technology adoption) may be accountable for growth s not observed in underdeveloped economies that operate a closed system and why a less developed economy with a large population can still benefit from economic integration with the rest of the world (Romer, 1990).

4.2 Method of Analysis

4.2.1 Model Specification

The model specification provides a general overview of the basic variables utilised during the analysis, adopted from Andres *et al* (2016), which assumes that the components of inclusive human development are growth components, institutions and technology. The functional form of the model is given as;

$$Y = f(A, S, X) \quad - - - - - - - - \quad (4.2)$$

Where A, S and X are the independent variables in the model and A is endogenous.

The model takes the form of the fixed proportion production function. The aggregate production with respect to time is;

$$Y_{(t)} = \alpha X_{(t)} + (1-\alpha) S_{(t)} + A_{(t)} \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad (4.3)$$

Where:

Y represents growth

X represents economic growth components

S represents socio-economic setting

A represents the Rate of Technical Progress

α is the elasticity of output with respect to capital and is less than one ($\alpha < 1$) which signifies diminishing returns.

Having described the Schumpeterian model of growth as the theoretical framework for this study, the implicit function is seen as follows:

$$Y_{it} = f(S_{it}, X_{it}, A_{it}). \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad (4.4)$$

Where A_{it} = INTUS, MCS, INVIT

S_{it} = RULE, PSE

X = GDPPCGR, CREDIT

Given that, it is assumed that the relationship between the dependent and independent variables is linear, the explicit form of the model is given as:

$$Y_{it} = \alpha_0 + \alpha_1 Y_{it-1} + \alpha_2 MCS_{it} + \alpha_3 PSE_{it} + \alpha_4 RULE_{it} + \alpha_5 CREDIT_{it} + \alpha_6 GDPPCGR_{it} + \mu_{it.} \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad (4.5)$$

$$Y_{it} = \beta_0 + \beta_1 Y_{it-1} + \beta_2 INTUS_{it} + \alpha_3 PSE_{it} + \alpha_4 RULE_{it} + \alpha_5 CREDIT_{it} + \alpha_6 GDPPCGR_{it} + \mu_{it.} \quad (4.6)$$

$$Y_{it} = \gamma_0 + \gamma_1 Y_{it-1} + \gamma_2 INVIT_{it} + \alpha_3 PSE_{it} + \alpha_4 RULE_{it} + \alpha_5 CREDIT_{it} + \alpha_6 GDPPCGR_{it} + \mu_{it.} \quad (4.7)$$

Where;

- Y_{it} represents human development index (which represents inclusive growth)
- Y_{it-1} represents the lagged dependent variable (to eliminate omitted variable bias)
- PSE_{it} represents primary school enrolment
- $RULE_{it}$ represents institution
- $CREDIT_{it}$ represents domestic credit provided by financial sector
- $GDPPCGR_{it}$ represents gross domestic product growth rate
- $INVIT_{it}$ represents capital investment in telecommunications
- INTUS – number of internet users
- MCS – Number of mobile cell subscribers

The dependent variable, human development index (HDI) is used as a proxy for human development - inclusive growth. Investment in telecommunication industry (INVIT) is used to replace for gross fixed capital formation (which is an essential component in the growth model) to reduce multicollinearity given the fact that investment in telecoms is a part of the gross fixed capital formation. It is significant to this study because it shows the level of investment in the ICT sector by public and private sectors.

Consistent with recent African knowledge economy, mobile technology is proxied by mobile sell subscription variable as in literature and supplemented by internet usage variable to measure ICT adoption (Tchamyou, 2015; Asongu, 2015c). OECD (2014) identifies gross domestic product per capita as one of the multidimensional components of inclusive growth which represents the economic growth component in the human development model. Primary school enrolment,

institutions – rule (Binder, M., & Geogiadis, G., 2011) and credit are necessary control variables essential to the Schumpeterian growth model to capture human development.

4.2.2 Apriori Expectations

A-priori expectations are the given facts which our research findings should follow. The results gotten from our analysis should be a confirmation of the theory followed. In this case, the use of the Schumpeter's theory which says that growth increases with more innovations, institutions and technology. Therefore, in this research, human development and ICTs should be positively related. That is: α_1, α_2, α_3, α_4, α_5, α_6, β_1, γ_2, β_2, $\gamma_2 > 0$. Specifically,

Lagged dependent variable: it has a direct relationship with total output hence; the coefficient carries a positive sign, α_1, β_1, $\gamma_1 > 0$.

Number of mobile cell subscribers: *a-priori* expectation here states that its coefficient has a positive sign. Meaning that, an increase in number of mobile cell phone users should bring about an increase in human development, hence, $\alpha_2 > 0$.

Number of internet users: it's *a-priori* expectation here also states that the coefficient has a positive sign meaning an increase in number of internet users is expected to bring about an increase in total human development and vice versa. This means that, the coefficient, $\beta_2 > 0$.

Investment in telecommunications: the coefficient is expected to have a direct positive relationship and therefore, a positive sign, $\beta 2 > 0$.

Primary school enrolment: The coefficient of primary school enrolment is expected to have a positive relationship on human development - $\alpha_3 > 0$

Rule: Institution is expected to have a positive effect on human development. That is $\alpha_4 > 0$

Domestic credit: Domestic credit provided by the financial sector is expected to have a positive effect on human development. That is $\alpha_5 > 0$

Gross domestic product per capita: GDP per capita is expected to have a positive effect on human development. That is $\alpha_6 > 0$

The stochastic term, μ, cannot be estimated because it is expected to be normally distributed with mean of zero and also have a constant variance.

4.3 Technique of Estimation

Two econometric methods will be used for the advanced panel data analysis. This is due to the fact that the dataset consists of observations across countries overtime, given the scope of the research. This panel data set combines both cross-sectional and time-series data. This implies that it has space as well as time dimension.

According to Gujarati and Porter (2009), below are some merits as well as some demerits of panel data:

1. The combination of time series and cross sectional data produces more information, data efficiency, variability, degrees of freedom, and less co-linearity in and among variables of interest.
2. Panel data accounts for the individual heterogeneity. It allows the control of variables that cannot be measured or observed such as cultural factors or variables that change overtime but not across entities such as national and sectorial policies.

3 Panel data creates a platform which enables the study of complicated and complex behavioural models

Given that everything that has merits also has some demerits, below are some of the demerits of the usage of panel data includes;

1. The process of data collection is cumbersome
2. Due to the combination of cross sectional and time-series data, the presence of heteroscedasticity and autocorrelation is bound to occur and is to be corrected.
3. Given the fact that the data spans across space and time, panel attrition (omitted data) could have a very drastic effect on the result (bias).

Torres- Reyna (2013) stated that panel data analysis could be specified using either the fixed effects model or the random effect model. In a case of dynamic panel (which has a lagged dependent variable, endogeneity issues), the generalised method of moments (GMM) is utilised.

Given the stated objectives of this research and the dynamic nature of the model, the methodologies to be used are:

4.3.1 Panel - Granger Causality Test

The panel granger non-causality test is a test developed from the simple test of non-causality by Granger (1969). The concept was proposed by Dumitrescu and Hurlin (2011) in their paper "Testing for Granger non-causality in heterogeneous panels". This method is used to determine the direction of causation within variables in a model. The Pairwise causality test is used to estimate the direction of causation.

4.3.2 Generalised Method of Moment

This research adopts a technique of estimation that allows the addressing of the triple problem of endogeneity, measurement error and omitted variables, Coxmanca and Manea (2009). In literature, the triple problem has been addressed jointly using first-differenced equation estimated by the generalised method of moments (GMM) approach proposed by Holtz-Eakin, Newey and Rosen (1988) and developed by Arrelano-Bond (1991) and popularly known as "Difference GMM".

Equation (1) can be re- written in its econometric form as:

$$Y_{it} - Y_{it-1} = \alpha (Y_{it-1} - Y_{it-2}) + \beta (S_{it} - S_{it-1}) + \gamma (A_{it} - A_{it-1}) + (\varepsilon_{it} - \varepsilon_{it-1}) \quad - \quad (4.8)$$

or

$$\Delta Y_{it} = \alpha \Delta Y_{it-1} + \beta \Delta S_{it} + \gamma \Delta A_{it} + \Delta \varepsilon_{it} \quad - \quad - \quad - \quad - \quad - \quad (4.9)$$

The Arellano – Bond (1991) method accounts for dynamic variant of equation 8 above which allows us to take into consideration the fact that the current HDI is also determined by the previous HDI of last year. The dynamic form of the model is seen as;

$$\Delta Y_{it} = \alpha \Delta Y_{it-1} + \beta \Delta A_{it} + \gamma Z_{it} + \nu_1 + \varepsilon_{it}$$

Where;

$\Delta Y_{it}$is the first difference of the natural logarithm of the dependent variable in country 'I' at time 't'

$\Delta Y_{it-1}$is the lagged difference of the dependent variable

$\Delta A_{it-1}$is a vector of lagged level and differenced pre-determined and endogenous variables

Z_{it} is a vector of endogenous variables and

α, β and γ are the parameters to be estimated.

The terms ν_1 and ε_{it} are assumed to be independent over all time period in country 'i'.

The country specific effects ν_1 and the stochastic term ε_{it} are defined in equation above.

The limitation of the differenced-GMM is shown when there is a persistent time series and small sample size (Alege & Ogundipe, 2013). This leads to poor performance, hence, the introduction and development of the "system-GMM" which was developed by Arellano-Bover (1995)/Blundell-Bond (1998). The GMM model eliminates serial correlation, heteroscedasticity, covers endogeneity problem, omitted variable bias. The major limitation of the difference GMM is that it magnifies gaps in unbalanced panel data. If there are gaps, the forward orthogonal deviations (FOD) transformation – system GMM, proposed by Arellano and Bover (J. Econometrics, 1995) is recommended.

The problem of dynamic endogeneity that is often associated with the use of panel data will be resolved by the use of the system GMM estimator to estimate the relationship between ICT adoption and human development. The system GMM estimator eliminates any bias that may arise from the dynamic endogeneity and also theoretically provides based and powerful instruments that account for simultaneity, while eliminating any unobservable heterogeneity (Davidson & Mackinnon, 2004; Alege & Ogundipe, 2013). The system-GMM estimator performs better than the differenced-GMM estimator in handling finite sample bias due to the exploitation of additional moment conditions, root mean square error, and multivariate dynamic panel models when the series are persistent (Bun & Windmeijer, 2009; Blundell, Bond & Windmeijer, 2000). Based on these considerations, the system GMM estimator is considered appropriate and applied in this study.

The computer software applications utilised in this research based on their various strengths are Eviews 9 and STATA12.

4.4. Data Sources and Measurement of Variables

The data set used during the research is a panel data of fifteen West Africa countries covering the period of 2004 to 2014. The data was sourced from World Development Indicators (WDI, 2016), World Governance Indicators (WGI, 2016), and United Nations Development Project (UNDP, 2015). The variables include the GDP per capita growth rate, investment in telecoms, mobile cell subscribers, fixed telephone lines, and the number of internet users, institutions, domestic credit by financial sector and primary school enrolment.

Table 4.1: Data and data sources

Data	Identifier	Data Source	Measurement
Human development index	HDI	UNDP, 2015	
Number of mobile cell subscribers	MCS	WDI, 2016	Number
Number of internet users	INTUS	WDI, 2016	Number
Investment in telecommunication	INVIT	WDI, 2016	Number
Primary school enrolment (pupils) – female	PSE	WDI, 2016	Number
Institution	RULE	WGI, 2016	Constant US$
Domestic credit by financial institutions	CREDIT	WDI, 2016	
Gross Domestic Product per capita growth rate	GDPPCGR	WDI, 2016	

Source: Compiled by researcher

CHAPTER FIVE

RESULTS AND DISCUSSIONS

This chapter focuses on the presentation, analysis and interpretation of the data for the study. It comprises the preliminary descriptive analysis – which shows the data features of each variable, the econometric analysis – multicollinearity, heteroscedasticity, panel granger causality and system- GMM estimation of results.

5.1. Descriptive Analysis

This shows the features of the data with respect to each variable. The tools utilised are mean, median, maximum, minimum, standard deviation, skewness, kurtosis, and so on.

Table 4.1 shows the statistical analysis of the variables – human development index, gross domestic product per capita growth rate (GDPPCGR), total investment in telecoms (INVIT),number of internet users (INTUS), mobile cell subscribers (MCS), domestic credit by financial sector (CREDIT), institutions (RULE) and primary school enrolment (PSE) of this study.

Mean – to find the average value and measure the extent of central tendency which is gotten by the sum of the values in the variable dataset divided by the total number of the values; median – the middle value in each variable dataset, maximum – which shows the highest value among each variable dataset and its country; minimum – which shows the lowest value among each variable dataset, standard deviation – which shows the positive square root of the variance where the variance is the difference between each of the values in each variable data set; skewness – which shows the degree of asymmetry of the distribution which could either be positively or negatively skewed, kurtosis – which measures the degree to which the frequency distribution is focused about the mean or the degree of peakedness of the distribution whereby it could be mesokurtic (when the kurtosis coefficient = 0), platykurtic (when the kurtosis coefficient > 0) and leptokurtic (when the kurtosis coefficient is < 0). The results are in Table 5.1.

Table 5.1 Summary Statistics of Variables for West Africa (2004 - 2014)

	HDI	INTUS	MCS	PSE	RULE	GDPPCGR	CREDIT	INVIT
Mean	0.44	2459510.	9591361.	46.72	-0.73	2.59	30.09	2.97E+08
Median	0.43	147113.7	2874560.	46.60	-0.80	2.06	20.78	75700000
Maximum	0.65	75746751	138960320	51.57	0.59	30.34	227.78	3060000000
Minimum	0.28	987.60	39451.00	40.34	-1.71	-9.06	4.27	250000.0
Std. Dev.	0.08	10330881	21225827	2.40	0.53	4.18	32.90	6.39E+08
Skewness	0.72	5.30	4.21	-0.15	0.52	2.28	3.56	3.17
Kurtosis	3.51	31.69	21.78	2.61	2.70	15.14	17.60	12.28
Jarque-Bera	16.08	6436.25	2844.75	1.29	8.07	1157.84	1782.46	715.90
Probability	0.00	0.00	0.00	0.52	0.02	0.00	0.00	0.00
Observations	165	165	161	130	165	165	162	136

Source: Researcher's compilation using E-views 9

From Table 5.1 – the summary of the dataset for this research, the maximum and minimum values show that the human development index grew as high as 0.65 which was found in Cape Verde at 2014 and as low as 0.28 in Niger as at 2004. GDP per capita growth rate grew as large as 30 percent in Nigeria at 2004 and as low as -9.06 percent in Mali at 2004.

Investment in Telecoms also grew as much as $3.06 billion and this was found in Nigeria at 2009 while it decreased to as low as $250000 in Sierra Leone in 2005. Internet Users (INTUS) increased to as much as 75746751 in Nigeria in 2014 and was as low as 987.5955 in Liberia in 2004. Mobile Cell Subscribers (MCS) increased to as much as 138960320 in Nigeria at 2014 and was as low as 39451.00 in Guinea Bissau at 2004.

Looking at the skewness, all the variables were positively skewed. This implies that the chance of getting an extremely negative outcome is very low compared to a negatively skewed dataset. Examining the kurtosis, all the variables had their entire kurtosis coefficient is greater than zero

(>0) which shows that the variable are leptokurtic. This also implies a low chance of getting a negative outcome.

5.2. Empirical Analysis and Discussion

This empirical section of the panel study consists of the multicollinearity test, serial correlation, system generalised method of moments (GMM) and panel granger causality.

5.2.1. Multicollinearity Test

Multicollinearity is an econometric problem that is occurs when there is a violation the OLS assumption of no perfect correlation existing between the independent variables within a model, given the fact that high correlation among the independent variables produces unrealistic results. The pairwise correlation matrix is used to determine the presence of multicollinearity in the dataset.

Table 5.2: Pairwise Correlation Matrix

	CREDIT	PSE	GDPPCGR	RULE
CREDIT	1.000000	0.352818	0.006957	0.273117
PSE	0.352818	1.000000	0.148325	0.201467
GDPPCGR	0.006957	0.148325	1.000000	0.208336
RULE	0.273117	0.201467	0.208336	1.000000

Source: Computed by the researcher using Eviews 9

The Table 5.2 presents the correlation matrix for the variables in the model; an incidence of strong correlation among the independent variables may violate the working assumptions of the estimation technique and hereby produce an unrealistic results. The result indicates that the strongest correlation is seen between mobile cell subscription and the number of internet users, followed by the relationship between labour and mobile cell subscribers. However, a perfect relationship (multicollinearity) does not exist between the variables. The overall assessment of the Pairwise correlation shows that multicollinearity is absent in the model.

5.2.2. Panel System – GMM Estimates

According to Baum (2013), the initial Arrelano – Bond (difference GMM) approach and its extension to the 'system GMM' framework, is an estimator designed for situations with 'small T, large N' panels: few time periods and many individual units, a linear functional relationship, one left-hand variable that is dynamic - depending on its own past realizations, right-hand variables that are not strictly exogenous: correlated with past and possibly current realizations of the error, fixed individual effects, implying unobserved heterogeneity, heteroscedasticity and autocorrelation within individual units' errors, but not across.

Table 5.3: SGMM RESULTS (Dependent variable: HDI)

	1	2	3
Human development index (-1)	0.96	1.13	0.88
	(0.00)	(0.00)	(0.00)
Mobile cell subscription	-1.30		
	(0.99)		
Internet usage		-3.32**	
		(0.09)	
Investment in telecommunications			5.07**
			(0.10)
Primary school enrolment	-.0003		.00017
	(0.26)		(0.64)
Rule of law (Institution)	-.0021	-.0087	0.0059
	(0.74)	(0.38)	(0.54)
Domestic credit provided by financial sector	-.00006	-.0001	,00009
	(0.48)	(0.393)	(0.40)
GDP per capita growth rate	0.00021	.0005*	0.00017
	(0.74)	(0.014)	(0.64)
Constant	-.0081	-.054	-0.014
	(0.75)	(0.219)	(0.77)
AR (1)Pr	0.379	0.153	0.58
AR (2)	0.361	0.115	0.36
Sargan Test	0.154	0.182	0.129
Prob> F	0.000	0.502	0.133
Number of instruments	8	9	8
Number of groups	15	15	15

Note: The values in the round parenthesis '()' are the probability values;

* denotes that the coefficients parameters are significant at 5% level. **signify that the coefficients parameters are significant at 10% level.

Compiled by the researcher; software package: Stata 12.

Three necessary conditions or requirements for the acceptance and interpretation of the SGMM results are the test for significance of the Sargan statistics, the test for serial correlation of the first order and second order and the comparison of the number of instruments against the number of groups.

The J statistics is also known as the Sargan test / Hansen test. It is a test that checks if the instruments (instrument variables) as a group are exogenous. The null hypothesis states that "the instruments as a group are exogenous". From the result above in table 5.3, the p-value of the Sargan test for the three results satisfy the rule of thumb that at 5 percent level of significance, given that they are higher than 0.05. Therefore, the instrument set can be considered valid and the SGMM result can be relied upon given that there is no over-identification.

The AR (1) and AR (2) tests for the presence of autocorrelation of the first order and second order. Given that the values of the AR (1) and AR (2) of the three different models are not statistically significant (> 0.05), there is absence of autocorrelation of the first order and second order. In terms of the comparison of the number of instruments against the number of groups, the rule of thumb says that the number of groups should be higher than the number of instruments. The number of groups are higher that the number of instruments for the three models. Therefore, the individual statistics could be interpreted.

The probability value (P>| t |) shows the individual significance of the variable coefficients at different confidence levels of significance (usually 1%, 5% and 10%)within the probability range of 0 and 1. The rule of thumb for the probability value of the t-statistics state that if the p-value is less than or equal to (≤) 0.05; accept the coefficient of the variables as significant for examining the impact of the independent variables on the dependent variable at 5 percent level of significance and if the probability value is less than or equal to (≤) 0.10, the variable is significant at 10 percent level of significance.

The major variables of interest in the model are mobile cell subscription (MCS), internet (INTUS) and investment in telecommunications (INVIT). The p-value of the t-statistics shows that the coefficients INTUS and INVIT are statistically significant at 10 percent level of significance given that the p-values of the variables are 0.09 and 0.10 respectively. Therefore, it could be deduced that the coefficients are statistically significant at 10 percent level of

significance, which allows for the interpretation of the results for policy analysis and recommendation.

However, the coefficients of mobile cell subscribers (MCS), internet users (INTUS) and investment in telecommunications (INVIT) are -1.30, -3.32 and 5.07. This result in terms of direction of impact, shows that mobile cell subscribers (MCS) has a negative impact on human development index despite the fact that MCS has no statistically significant relationship with the human development index. Internet usage (INTUS) has a negative impact on human development index while investment in telecommunications (INVIT) has a positive impact on human development index in West Africa.

Also, according to the results of this research, in terms of magnitude, a unit increase in the Number of internet users (INTUS) within West Africa will lead to a negative unit change (decrease) by 3.32 in human development index (HDI) while a unit increase in the investment in telecommunications (INVIT) within West Africa will lead to a positive unit change (increase) by 5.07 in human development index (HDI).

In comparison to the apriori expectation, mobile cell phone subscribers (MCS) variable does not follow the apriori expectation by $\beta_4 < 0$, internet users (INTUS) variable does not follow the apriori expectation by $\beta_3 < 0$ while INVIT variable follows the apriori expectation by $\beta_3 > 0$. The apriori expectation is correct because the usage of mobile phones and internet enables increased efficiency overtime, helps to solve problems through research and dissemination of information across physical barriers at a very short time.

The negative impact of the internet users and mobile cell subscription on human development index could be accounted for by the high cost of acquisition and usage internet facilities and other mobile technologies in West Africa, usage of these technologies for non-economically productive reasons by the citizens, the low penetration of these technologies enough to positively affect the human development and cause inclusive growth. In summary, the alternative form of hypothesis one, which states that "ICT adoption contributes significantly to inclusive growth in West Africa", is accepted and the null hypothesis form is rejected.

This suggests that an improvement in ICT adoption is a important factor in accounting for the variation in inclusive growth of countries in West Africa. The results from table 5.3 confirm the

importance of the ICT adoption in West African countries. The findings are in line with Asongu (2014; 2016).

The mechanisms through which ICT could lead to inclusive growth are firstly, through spontaneous information dissemination. The transmission is initiated from the various theories (possible reasons) on how and why a new technology is adopted by an individual, firm, country- in this case; the ICT is then utilised by the population to reduce the information asymmetry (information variance) between the different users at the various sides (supply and demand) of each value chain that exists in all the sectors and markets in an economy. Secondly, access to ICT reduces transaction costs associated with the markets (i.e. savings in time and travel) and assist in the expansion of market boundaries (Aker & Mbiti, 2010; Asongu *et al* 2016).

These in turn will increase productivity overtime economic growth, human development and furthermore, inclusive growth. Inclusive growth is achieved through the increased participation of the labour force in the various economic activities; which is in line with the definition of inclusive growth; that is, creating equal opportunities for all in an economy. This transmission pass - through could be applied to the labour market, capital market, all sectors of the economy including education sector, health sector, agriculture sector, and so on.

5.2.3. Granger Causality Test

Table 5.4: Causality Results at Lag Time Period 1

PAIRWISE GRANGER CAUSALITY TESTS (Sample: 2004 2014; Lags: 1)			
Null Hypothesis:	Obs	F-Statistic	Prob.
INTUS does not Granger cause HDI	150	0.17434	0.6769
HDI does not Granger cause INTUS		0.37177	0.5430
MCS does not Granger cause HDI	145	0.21090	0.6468
HDI does not Granger cause MCS		0.00428	0.9480
PSE does not Granger cause HDI	107	0.07800	0.7806
HDI does not Granger cause PSE		10.8726	0.0013
RULE does not Granger cause HDI	150	10.5153	0.0015
HDI does not Granger cause RULE		4.15263	0.0434
GDPPCGR does not Granger cause HDI	150	0.33663	0.5627
HDI does not Granger cause GDPPCGR		0.25912	0.6115
MCS does not Granger cause INTUS	145	21.1305	9.E-06
INTUS does not Granger cause MCS		10.2393	0.0017
PSE does not Granger cause INTUS	107	0.29777	0.5865
INTUS does not Granger cause PSE		0.00233	0.9616
RULE does not Granger cause INTUS	150	1.15391	0.2845
INTUS does not Granger cause RULE		0.07490	0.7847
GDPPCGR does not Granger cause INTUS	150	3.48210	0.0640
INTUS does not Granger cause GDPPCGR		0.06484	0.7994
HDI does not Granger cause INVIT	119	0.06362	0.8013
INVIT does not Granger cause HDI		0.06120	0.8050

By researcher; software package: Eviews9

Table 5.5: Causality Results at Lag Time Period 2

PAIRWISE GRANGER CAUSALITY TESTS (Sample: 2004 2014; Lags: 2)			
Null Hypothesis:	Obs	F-Statistic	Prob.
INTUS does not Granger cause HDI	135	0.16266	0.8501
HDI does not Granger cause INTUS		0.32837	0.7207
MCS does not Granger cause HDI	129	0.37605	0.6873
HDI does not Granger cause MCS		2.63107	0.0760
PSE does not Granger cause HDI	90	0.90066	0.4101
HDI does not Granger cause PSE		4.54103	0.0134
RULE does not Granger cause HDI	135	7.86236	0.0006
HDI does not Granger cause RULE		2.68013	0.0723
GDPPCGR does not Granger cause HDI	135	0.66623	0.5154
HDI does not Granger cause GDPPCGR		0.12599	0.8817
MCS does not Granger cause INTUS	129	8.12640	0.0005
INTUS does not Granger cause MCS		2.04760	0.1334
PSE does not Granger cause INTUS	90	0.46491	0.6298
INTUS does not Granger cause PSE		0.02189	0.9784
RULE does not Granger cause INTUS	135	0.27229	0.7621
INTUS does not Granger cause RULE		0.21502	0.8068
GDPPCGR does not Granger cause INTUS	135	0.98316	0.3769
INTUS does not Granger cause GDPPCGR		0.12360	0.8838
PSE does not Granger cause MCS	87	0.98105	0.3793
MCS does not Granger cause PSE		0.10048	0.9045
RULE does not Granger cause MCS	129	0.10730	0.8983
MCS does not Granger Cause RULE		0.32274	0.7248
GDPPCGR does not Granger Cause MCS	129	4.41242	0.0141
GDPPCGR does not Granger Cause RULE	135	0.96347	0.3843
RULE does not Granger Cause GDPPCGR		8.05315	0.0005
HDI does not Granger Cause INVIT	103	0.26365	0.7688
INVIT does not Granger Cause HDI		0.01500	0.9851

By researcher; software package: Eviews9

Table 5.4 and 5.5 shows the null hypothesis of the direction of causality between the variables. The rule of thumb states that if F statistics is greater than or equal to 3.84 ($F \geq 3.84$) then the alternative hypothesis is accepted but if vice versa, the null hypothesis is accepted. The results show that ICT adoption in terms of mobile cell subscription, internet usage and investment in telecoms do not significantly granger cause human development index (HDI) at lag 1 and at lag

2. However, a bidirectional cause and effect relationship exists between institutions (RULE) and human development index (HDI) at lag 1 and a unidirectional relationship at lag 2.Also, mobile cell Subscribers (MCS) at lag period 1 and 2, Granger cause internet users (INTUS). ICT adoption does not have a significant causal influence on human development in West Africa at the first and second time periods (Lags).

In sum, based on these empirical results and findings, the null form of the second hypothesis which states that "ICT adoption does not significantly *Granger cause* human development in West Africa at the immediate or next time period" is accepted. This implies that at the immediate time period (lag 1 – one year) and at 2 lag time period (2 years), ICT adoption does not significantly Granger cause inclusive growth illuminates the point that there is likely to be a slow response of inclusive growth to ICT adoption - it most likely takes some time. However, there is also the likelihood that with much ICT adoption, at future time periods, ICT adoption would have a significant causal influence on inclusive growth. Also, the limited time series data (based on data availability - 11 years) could also account for this negative result of ICT adoption not significantly Granger-causing inclusive growth at the immediate or next time period.

It is important to state clearly that the possible reason for the non causal relationship between ICT adoption - mobile cell subscription, internet usage and investment in telecommunications and inclusive growth would most likely be the high utilisation of these tools for non economically productive reasons; the slow adoption of ICT in West Africa; high cost of ICT facilities such as smart phones (internet enabled phones), internet subscription and others in West Africa.

CHAPTER SIX

RECOMMENDATIONS AND CONCLUSION

This chapter focuses on the summary of the study of the major findings of ICT adoption and inclusive growth – human development in West Africa, policy recommendations and conclusion. It also comprises the preliminary contribution to knowledge and the limitations of the study.

6.1 Summary

Inclusive growth is a major issue in developing economies. Evidence from relevant data has shown that West Africa has been experiencing non-inclusive growth (economic growth without inclusiveness of all) accompanied by a fast rising population. This, therefore, necessitates the need to examine the nature of the relationship between information and communication technology (ICT) and inclusive growth in terms of human development in West Africa. This research work was motivated with a view to determining the degree of pass-through from ICT to inclusive growth through human development. Human development could be broken down into improved provision of health care services, educational services and improved standard of living while inclusive growth comprises of human development alongside improved banking and financial services, improved agricultural output, and so on.

Considering the relationship between ICT and Inclusive growth, the diffusion theory of innovation was adopted as the theoretical frame work of the study. The study employs the panel generalised method of moments with orthogonal deviations transformation, panel granger causality methods to achieve its objectives. The study makes use of panel data spanning from 2004 to 2014 across 15 West African countries. The variables used in this research are GDP per capita growth rate, investment in telecoms, number of mobile cell subscribers, number of internet users, human development index, institutions, primary school enrolment, and domestic credit from financial institutions. All data are sourced from the World Bank Data (World Development Indicators - WDI, 2016, World Governance Indicators – WGI, 2016) and United Nations Development Project (UNDP, 2015).

The results from the empirical analysis reveal that internet usage has a negative significant impact on human development (HDI) which does not follow the theory of innovation and could

be accounted for by factors such as high cost, non-economically productive use of the internet facilities, slow adoption of the technology and rapid population increase overtime. Mobile Technology was seen to have a positive significant impact on human development, which follows the diffusion theory and apriori expectation which posit that the adoption of a new technology leads to growth. Investment in telecommunications was seen to have a positive and statistically significant impact on human development.

In terms of causality, the pairwise granger causality results show that at the 1st and 2nd lag periods, internet users, mobile subscription and investment in telecommunication do not significantly granger cause human development in West Africa.

6.2 Recommendations

Given the empirical investigations which have been conducted in this study, it is necessary that policies be designed and directed towards the attainment of inclusive growth in West Africa and beyond based on the research findings. On this note, the following policies are recommended in order to ensure that this goal is achieved in West Africa:

Firstly, this study recommends that to reduce the digital divide among the fast adopting and adopting countries, government and private individuals must be prepared to commit to increased and sustainable investment in ICT to encourage research in ICT, increase development of web and mobile applications for businesses, improve ICT encryption security to curtail data theft as the utilisation of ICT increases overtime.

Secondly, the use of cutting edge information and communication technology facilities should be encouraged by private and public companies, institutions offering health care services, education services, agriculture, and financial services to improve efficiency by reaching out to far distances to increase coverage for everyone overtime. The ICT facilities being referred to, are mobile phone applications, internet enabled applications, internet facilities, and so on.

Thirdly, this study recommends that more awareness should be made about the economically productive use of these information and communication technologies, the advantages of the use of ICT in delivering services. This will help to speed up the adoption rate of ICT. Human beings

need to see reasons why they are to invest in ICTs such as internet subscriptions, smart mobile phone for applications,

Fourthly, The ICT market (especially in countries in West Africa like Nigeria, South Africa) operates an oligopolistic market which consists of few sellers and many buyers. This gives the opportunity for the cartel to determine and set high unrealistic prices for ICTs for extreme profits. Hence, there is a need for monitored price regulation on the cost of obtaining and providing technology such as the price of monthly internet subscriptions to make things affordable for the common man.

Also, tax holidays should be given to companies involved in innovative activities with ICTs, given that ICTs are at the forefront of many innovative activities occurring in West Africa (Asongu *et al*, 2016).

Lastly, the adoption of ICT by the government in registration processes, tax administration, payroll dissemination, and handling of financial obligations will help to reduce corruption in terms of reduction of ghost workers, reduction of tax evasion and to increase efficiency in terms of payment of salaries at due times across places, will help to create a database for administration of social security when necessary.

6.3. Contribution to Knowledge

Literature review revealed some gaps such as: (i) very few researches on ICT adoption and its relationship with human development - inclusive growth (ii) no ICT adoption and human development research focus particularly on West Africa considering variables such as investment in telecoms, mobile technology and internet technology, with other control variables such as institutions, economic growth component and so on, to my knowledge (iii) few works using the GMM empirical methodology (considering the lagged dependent variable) together with the granger causality method for measuring impact and observing direction of causality at the 1st lag and 2nd lag. In view of the gaps above, this study filled this gap and contributed to the very thin literature that exists in ICT adoption and how it contributes to inclusive growth - human development using the GMM approach and Granger causality techniques of estimation.

This study reviewed different models of ICT adoption for development such as Pakistan's strategy for ICT, UNESCO's inclusive growth web, Johnson's inclusive growth pyramid and went further to develop a model for the transmission from ICT adoption to economic and inclusive growth and a model with the application of theories relevant to this work. The model of transmission from ICT adoption to human development and inclusive growth emphasised on the creation of jobs, providing education for all, improved research and development for more productivity, financial inclusion, improved value chain interaction and social media connection.

The model with application of theories relevant to this work linked the Technology acceptance model, diffusion of innovation theory through the search and matching theory down to economic and inclusive growth.

6.4. Conclusion

Of the three components of ICT adoption (mobile cell subscription, internet usage and investment in telecommunications) tested by this study, mobile cell subscription and investment in telecommunications did prove to play a significant role in human development in West Africa while internet usage did prove to play an insignificant role. Furthermore, mobile cell subscription and internet usage did show a negative impact. In the light of these findings, about two main issues were identified as possible reasons for this contradictory result (to the Apriori expectation): the non – productive use of these technologies in West Africa and the high cost of the obtainment of these ICTs by individuals in West Africa.

This study has to a great extent validated the important role of ICT in promoting inclusive growth and human development. Countries like Japan, South Korea, India, Singapore and the other countries among the Asian tigers have shown that adoption and investing in technologies such as information and communication technologies can spur growth (inclusive and financial), given that they were all at the same level of low growth and development with other developing countries at 1980. However, there is a now a template for developing countries such as Nigeria, Gambia, Ghana as well as other countries in West Africa.

In conclusion, the adoption of ICT has been proven statistically to be significant in contributing to human development thereby creating opportunities for more citizens across physical barriers

overtime; nevertheless, ICT adoption is more of capital intensive in nature. On this note, ICT plays a crucial role in human development.

6.5. Limitations of the Study and Suggestions for Further Studies

This research's major limitation is the unavailability of large time series dimension for the West African countries, which still had some attrition. However, the method of estimation catered for the limitation to its possible best.

The following suggestions are made for further studies: The impact of information and communication technology on health care services, unemployment, education and financial services could also be looked at specifically at the micro sector level; A comparative analysis of impact of ICT on economic growth between ICT empowered economies, ICT adopting and ICT deficient economies at the macro level. The linkage between ICT adoption, exchange rates and human development could be looked at to examine the linkage given that most West African countries are import dependent, therefore are subject to exchange rate fluctuations.

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APPENDICES

Appendix A: The GDP Per Capita ($US) of West African countries (2004- 2014).

GDPPC	2004 - 2006	2007 - 2009	2010 - 2012	2013 - 2014
Benin	710.84	737.47	738.03	792.24
Burkina Faso	1099.40	1214.83	1455.01	1657.76
Cape-Verde	2655.82	3346.95	3460.19	3509.77
Cote d'Ivoire	1228.65	1229.01	1213.01	1369.91
Ghana	1099.40	1214.83	1455.01	1657.76
Guinea	439.24	439.23	434.93	432.96
Guinea Bissau	489.67	503.21	534.33	522.28
Liberia	280.83	313.48	343.32	379.25
Mali	505.36	611.11	744.68	844.65
Mauritania	1109.84	1217.04	1237.70	1327.25
Niger	330.91	340.96	355.73	380.40
Nigeria	1894.77	2123.14	2359.32	2505.12
Sierra Leone	391.76	429.05	484.32	631.06
Senegal	955.12	986.74	993.51	1005.40
Togo	490.21	489.00	506.81	531.71

Source: Computed by the Researcher using data from World Bank (2016a)

Appendix B: The Number of Internet Users in West African Countries (2004 - 2014)

INTUS	2004 - 2006	2007 - 2009	2010 – 2012	2013 - 2014
Benin	109180.92	176291.63	385192.68	570849.14
Burkina Faso	67584.07	137892.36	492129.56	1604039.51
Cape-Verde	28771.31	69934.00	159855.60	198560.15
Cote d'Ivoire	207178.24	366396.18	732069.70	2525613.39
Ghana	32589.34	114277.99	214070.73	291936.26
Guinea	54563.38	91950.72	143507.34	201159.34
Guinea Bissau	28149.68	35748.00	44791.63	57124.15
Liberia	3970.35	38439.01	100655.71	187625.85
Mali	72141.11	199753.10	366183.85	888372.46
Mauritania	22548.70	63803.59	166084.76	332428.14
Niger	31894.75	93806.36	201262.24	342409.18
Nigeria	4883877.90	21656866.9	46668263.82	70708513.64
Sierra Leone	10915.90	13805.68	55080.48	118834.38
Senegal	556726.10	878031.93	1277927.07	2229999.48
Togo	98826.57	145524.46	230455.01	358678.32

Source: Computed by the Researcher using data from World Bank (2016a)

Appendix C: Fixed Telephone lines in West African countries (2004 - 2014)

FXTL	2004 - 2006	2007 - 2009	2010 - 2012	2013 - 2014
Benin	75466	117734.33	147619	177552.5
Burkina Faso	90391.33	139121.33	142283.33	131008
Cape-Verde	71626	71832.67	72231.33	62355.5
Cote d'Ivoire	262340	295381.67	278657.33	257414.5
Ghana	330402.33	262599.33	282533	265414.5
Guinea	24733.33	23666.67	18000	
Guinea Bissau	8705.67	4688.33		
Liberia		2140.67	9609.67	10520
Mali	74753	81959	110407	140389.5
Mauritania	38290	63695	69645	52712.5
Niger	25973	60920	89758	102900
Nigeria	1312916.30	1456429.7	729269.67	271913.5
Sierra Leone	27766.67	31533.33	16000	16250
Senegal	264711	261876	342760.67	327831.5
Togo	70279	139705	60624.67	57924

Source: Computed by the Researcher using data from World Bank (2016a)

Appendix D: Investment in Telecoms ($US) in West African countries (2004 - 2014)

INVIT	2004 - 2006	2007 - 2009	2010 - 2012	2013 - 2014
Benin	9566666.667	165033333.3	171566666.7	44700000
Burkina Faso	290000000	130200000	140366666.7	41300000
Cape-Verde	16000000	14566666.67	14833333.33	
Cote d'Ivoire	19266666.67	352566666.7	310866666.7	216500000
Ghana	115733333.3	900333333.3	274066666.7	174400000
Guinea	26866666.67	64733333.33	132466666.7	178950000
Guinea Bissau	3450000	29400000	13200000	9150000
Liberia	26943333.33	21100000	14950000	
Mali		194333333.3	190333333.3	76850000
Mauritania	121000000	37700000	133000000	
Niger		83900000	98633333.33	25100000
Nigeria	1972350000	2937666667	2216300000	1735100000
Sierra Leone	18416666.67	23733333.33	21200000	9100000
Senegal	157666666.7	373666666.7	225166666.7	95800000
Togo		44000000	19733333.33	23300000

Source: Computed by the Researcher using data from World Bank (2016a)

Appendix E: The Average of the Number of Mobile Cell Subscribers in West African countries (2004 - 2014)

MCS	2004 - 2006	2007 - 2009	2010 - 2012	2013 - 2014
Benin	703772	3570163.7	7749322	9143939.5
Burkina Faso	682032.667	2901937.7	7788685	11867638.5
Cape-Verde	85453	240167.67	397870	556418
Cote d'Ivoire	2696397.33	10367017	17014273	20747738.5
Ghana	3258934	11427800	21407073	29193626.5
Guinea	171950	2746333.3	4815096.7	8059985.5
Guinea Bissau	98535.3333	452241.33	819730.67	1024103
Liberia	178123.333	834229.67	1990615	2888016.5
Mali	893931.667	3476667.3	10958383	21627465
Mauritania	776045.667	1896069.3	3372098.3	3870762.5
Niger	326424.667	1798876	4602348	7621350
Nigeria	20018803.7	59300789	98414294	133103206
Sierra Leone		981600	2115666.7	4378400
Senegal	1944681	5307143	9722410.3	13756750.5

Togo	491400	1642398.3	2869952.3	4389553.5

Source: Computed by the Researcher using data from World Bank (2016a)

Appendix F: Descriptive Statistics Result

	HDI	INTUS	MCS	PSE	RULE	GDPPCGR	CREDIT	INVIT
Mean	0.44	2459510.	9591361.	46.72	-0.73	2.59	30.09	2.97E+08
Median	0.43	147113.7	2874560.	46.60	-0.80	2.06	20.78	75700000
Maximum	0.65	75746751	138960320	51.57	0.59	30.34	227.78	3060000000
Minimum	0.28	987.60	39451.00	40.34	-1.71	-9.06	4.27	250000.0
Std. Dev.	0.08	10330881	21225827	2.40	0.53	4.18	32.90	6.39E+08
Skewness	0.72	5.30	4.21	-0.15	0.52	2.28	3.56	3.17
Kurtosis	3.51	31.69	21.78	2.61	2.70	15.14	17.60	12.28
Jarque-Bera	16.08	6436.25	2844.75	1.29	8.07	1157.84	1782.46	715.90
Probability	0.00	0.00	0.00	0.52	0.02	0.00	0.00	0.00

Observations	165	165	161	130	165	165	162	136

Source: Researcher's compilation using E-views 9

Appendix G: Multicollinearity Result

	CREDIT	PSE	GDPPCGR	RULE
CREDIT	1.000000	0.352818	0.006957	0.273117
PSE	0.352818	1.000000	0.148325	0.201467
GDPPCGR	0.006957	0.148325	1.000000	0.208336
RULE	0.273117	0.201467	0.208336	1.000000

Source: Researcher's compilation using E-views 9

Appendix H: GMM Results

1. MCS

```
. xtabond2  hdi l.hdi mcs gdppcgr pse rule credit, gmm( hdi l.hdi mcs, lag (2 2) collapse equation (l
> evel)) iv( gdppcgr pse credit rule) small twostep robust arlevels
Favoring space over speed. To switch, type or click on mata: mata set matafavor speed, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       116
Time variable : year                            Number of groups   =        15
Number of instruments = 8                       Obs per group: min =         1
F(6, 14)      =    976.96                                      avg =      7.73
Prob > F      =     0.000                                      max =        10
------------------------------------------------------------------------------
             |              Corrected
         hdi |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hdi |
         L1. |   .9602279   .0848681    11.31   0.000     .7782039    1.142252
             |
         mcs |  -1.30e-12   1.15e-10    -0.01   0.991    -2.47e-10    2.44e-10
     gdppcgr |    .000298   .0002543     1.17   0.261    -.0002475    .0008435
         pse |   .0003033   .0012942     0.23   0.818    -.0024724    .0030791
        rule |   .0021338   .0061789     0.35   0.735    -.0111187    .0153863
      credit |   .0000572   .0000789     0.72   0.481    -.0001121    .0002265
       _cons |   .0080892   .0246077     0.33   0.747    -.0446891    .0608675
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(gdppcgr pse credit rule)
Instruments for levels equation
  Standard
    gdppcgr pse credit rule
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.(hdi L.hdi mcs) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in levels:            z =  -0.88  Pr > z =  0.379
Arellano-Bond test for AR(2) in levels:            z =   0.91  Pr > z =  0.361
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(1)    =   2.03  Prob > chi2 =  0.154
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(1)    =   1.62  Prob > chi2 =  0.202
  (Robust, but weakened by many instruments.)
```

2. INTUS

```
. xtabond2  hdi l.hdi intus gdppcgr rule credit, gmm( hdi l.hdi intus, lag (2 1) collapse equatio
> n (level)) iv( gdppcgr credit rule) small twostep robust arlevels
Favoring space over speed. To switch, type or click on mata: mata set matafavor speed, perm.
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       148
Time variable : year                            Number of groups   =        15
Number of instruments = 9                       Obs per group: min =         8
F(5, 14)      =     93.87                                        avg =      9.87
Prob > F      =     0.000                                        max =        10
------------------------------------------------------------------------------
             |              Corrected
         hdi |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hdi |
          L1.|   1.132453   .084758    13.36   0.000     .9506652    1.314241
             |
       intus |  -3.32e-10   1.88e-10   -1.77   0.099    -7.35e-10    7.12e-11
     gdppcgr |   .0005383    .000192    2.80   0.014     .0001264    .0009502
        rule |  -.0087291   .0097496   -0.90   0.386      -.02964    .0121819
      credit |  -.0001025   .0001163   -0.88   0.393    -.0003518    .0001469
       _cons |  -.0548694   .0426354   -1.29   0.219    -.1463131    .0365744
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(gdppcgr credit rule)
Instruments for levels equation
  Standard
    gdppcgr credit rule
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL(1/2).(hdi L.hdi intus) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in levels:            z =   1.43  Pr > z =  0.153
Arellano-Bond test for AR(2) in levels:            z =   1.58  Pr > z =  0.115
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(3)    =   4.86  Prob > chi2 =  0.182
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(3)    =   2.35  Prob > chi2 =  0.502
  (Robust, but weakened by many instruments.)
```

3. INVIT

```
. xtabond2  hdi l.hdi invit gdppcgr pse rule credit, gmm( hdi l.hdi invit, lag (2 2) collapse equatio
> n (level)) iv( gdppcgr pse credit rule) small twostep robust arlevels
Favoring space over speed. To switch, type or click on mata: mata set matafavor speed, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       100
Time variable : year                            Number of groups   =        15
Number of instruments = 8                       Obs per group: min =         1
F(6, 14)      =    298.89                                      avg =      6.67
Prob > F      =     0.000                                      max =        10
------------------------------------------------------------------------------
             |              Corrected
         hdi |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hdi |
         L1. |   .8831855   .1489093     5.93   0.000     .5638069    1.202564
             |
       invit |   5.07e-12   2.90e-12     1.75   0.102    -1.15e-12    1.13e-11
     gdppcgr |   .0001711    .000365     0.47   0.646    -.0006117    .0009538
         pse |   .0014986   .0023487     0.64   0.534    -.0035388     .006536
        rule |   .0059317   .0094346     0.63   0.540    -.0143035     .026167
      credit |   .0000966   .0001122     0.86   0.404    -.0001441    .0003373
       _cons |  -.0140864   .0484552    -0.29   0.776    -.1180124    .0898397
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(gdppcgr pse credit rule)
Instruments for levels equation
  Standard
    gdppcgr pse credit rule
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.(hdi L.hdi invit) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in levels:            z =   0.55  Pr > z =  0.580
Arellano-Bond test for AR(2) in levels:            z =   0.91  Pr > z =  0.364
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(1)    =   2.31  Prob > chi2 =  0.129
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(1)    =   2.25  Prob > chi2 =  0.133
  (Robust, but weakened by many instruments.)
```

Appendix I: Granger Causality Results

PAIRWISE GRANGER CAUSALITY TESTS

Sample: 2004 2014

Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
INTUS does not Granger cause HDI	150	0.17434	0.6769
HDI does not Granger cause INTUS		0.37177	0.5430
MCS does not Granger cause HDI	145	0.21090	0.6468
HDI does not Granger cause MCS		0.00428	0.9480
PSE does not Granger cause HDI	107	0.07800	0.7806
HDI does not Granger cause PSE		10.8726	0.0013
RULE does not Granger cause HDI	150	10.5153	0.0015
HDI does not Granger cause RULE		4.15263	0.0434
GDPPCGR does not Granger cause HDI	150	0.33663	0.5627
HDI does not Granger cause GDPPCGR		0.25912	0.6115
MCS does not Granger cause INTUS	145	21.1305	9.E-06
INTUS does not Granger cause MCS		10.2393	0.0017
PSE does not Granger cause INTUS	107	0.29777	0.5865
INTUS does not Granger cause PSE		0.00233	0.9616
RULE does not Granger cause INTUS	150	1.15391	0.2845
INTUS does not Granger cause RULE		0.07490	0.7847
GDPPCGR does not Granger cause INTUS	150	3.48210	0.0640
INTUS does not Granger cause GDPPCGR		0.06484	0.7994
HDI does not Granger cause INVIT	119	0.06362	0.8013
INVIT does not Granger cause HDI		0.06120	0.8050

PAIRWISE GRANGER CAUSALITY TESTS

Sample: 2004 2014

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
INTUS does not Granger cause HDI	135	0.16266	0.8501
HDI does not Granger cause INTUS		0.32837	0.7207
MCS does not Granger cause HDI	129	0.37605	0.6873
HDI does not Granger cause MCS		2.63107	0.0760
PSE does not Granger cause HDI	90	0.90066	0.4101
HDI does not Granger cause PSE		4.54103	0.0134
RULE does not Granger cause HDI	135	7.86236	0.0006
HDI does not Granger cause RULE		2.68013	0.0723
GDPPCGR does not Granger cause HDI	135	0.66623	0.5154
HDI does not Granger cause GDPPCGR		0.12599	0.8817
MCS does not Granger cause INTUS	129	8.12640	0.0005
INTUS does not Granger cause MCS		2.04760	0.1334
PSE does not Granger cause INTUS	90	0.46491	0.6298
INTUS does not Granger cause PSE		0.02189	0.9784
RULE does not Granger cause INTUS	135	0.27229	0.7621
INTUS does not Granger cause RULE		0.21502	0.8068
GDPPCGR does not Granger cause INTUS	135	0.98316	0.3769
INTUS does not Granger cause GDPPCGR		0.12360	0.8838
PSE does not Granger cause MCS	87	0.98105	0.3793
MCS does not Granger cause PSE		0.10048	0.9045
RULE does not Granger cause MCS	129	0.10730	0.8983
MCS does not Granger Cause RULE		0.32274	0.7248
GDPPCGR does not Granger Cause MCS	129	4.41242	0.0141
MCS does not Granger Cause GDPPCGR		0.07977	0.9234
RULE does not Granger Cause PSE	90	0.26721	0.7661
PSE does not Granger Cause RULE		0.03269	0.9679
GDPPCGR does not Granger Cause PSE	90	0.06975	0.9327
PSE does not Granger Cause GDPPCGR		0.35673	0.7010
GDPPCGR does not Granger Cause RULE	135	0.96347	0.3843
RULE does not Granger Cause GDPPCGR		8.05315	0.0005
HDI does not Granger Cause INVIT	103	0.26365	0.7688
INVIT does not Granger Cause HDI		0.01500	0.9851